



INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

Applicant's or agent's file reference M/44167-PCT	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP 03/06327	International filing date (day/month/year) 16.06.2003	Priority date (day/month/year) 17.06.2002
International Patent Classification (IPC) or both national classification and IPC H01M8/04		
Applicant NUVERA FUEL CELLS EUROPE S.R.L. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 15.01.2004	Date of completion of this report 06.09.2004
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Jacquinot, P Telephone No. +49 89 2399-7239 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/06327**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17):*

Description, Pages

1-20 as originally filed

Claims, Numbers

1-28 as originally filed

Drawings, Sheets

1/10-10/10 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/06327**

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).
(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:
- ☐ the entire international application,
 - ☒ claims Nos. 28
because:
 - ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):
 - ☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 28 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet
 - ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
 - ☐ no international search report has been established for the said claims Nos.
2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:
- ☐ the written form has not been furnished or does not comply with the Standard.
 - ☐ the computer readable form has not been furnished or does not comply with the Standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	9-26
	No: Claims	1-8,27
Inventive step (IS)	Yes: Claims	14-26
	No: Claims	9-13
Industrial applicability (IA)	Yes: Claims	1-26
	No: Claims	

2. Citations and explanations

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/EP 03/06327

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP 03/06327

Re item III

1. Clarity

- 1.1 The subject-matter of **claim 28** is unclear under Article 6 PCT. A claim cannot be defined with the only characterizing part being a reference to drawings. As the aimed scope of protection is unclear, the assessment of novelty, inventive step and industrial applicability is not possible.

Re Item V

1. Considered documents

The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

- D1: US-A-5 998 054 (JONES DANIEL O ET AL) 7 December 1999 (1999-12-07)
D2: EP-A-1 286 404 (EQUOS RES KK) 26 February 2003 (2003-02-26)
D3: WO 00/70698 A (BRAMBILLA MASSIMO ;MAZZUCHELLI GABRIELE (IT);
FLEBA GIAN PIERO (I) 23 November 2000 (2000-11-23)

2. Novelty

The subject-matter of claims 1-8 and 27 appears not to satisfy the requirements of novelty according to Article 33(2) PCT:

- 2.1 D1(US 5998054) discloses in Figures 2-4 a PEM-FC system comprising separator plates (120) having aligned injection holes (131) for injecting liquid water from an input channel (140) into the reactant gas bearing gas flow channels (126) in order to humidify and implicitly also cooling the system. Carbon fabric serves as gas diffusion layer (reticulated element; column 5, lines 11-14). The diameter of the injection holes varies between 0.127-0.254 mm (column 5, line 64-67). The gasket (136) leaves a space for a fluid collection channel (134). Therefore, the subject-matter of **claims 1-8 and 27** is regarded as not being novel.

3. Inventive step

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EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP 03/06327

The subject-matter of claims 9-13 appears not to satisfy the requirements of inventiveness according to Article 33(3) PCT:

3.1 **D1** is regarded as the closest prior art with respect to claim 9. It differs from the present application insofar as a multiplicity of additional cells (101) is lacking. These additional cells serve for cooling the stack whilst preheating the water in order to effectively humidify the reactant gas. The problem to be solved might be formulated such as how to provide the thermal energy to the humidifying fluid for an evaporative humidification/cooling management. The solution, however, appears obvious for the skilled person in view of the teaching of **D3** (WO 0070698) which proposes the incorporation of devices (11) (see page 15, line 10 to page 16, line 12 and Figures 3-5) comprising electrically reticulated elements (5'), corresponding channels and openings between reaction cells. Furthermore, one or more water injection channels (15) are placed below feed openings (13) (see page 16, lines 7-12 and Figure 4). Therefore, the subject-matter of **claims 9-13** is regarded as lacking an inventive step.

3.2 The subject-matter of **claim 14** and its depending **claims 15-26**, however, is regarded as involving an inventive step, because a generator having conductive bipolar plates comprising the (known) multiplicity of fluid injection holes, further comprising a multiplicity of first and a multiplicity of second calibrated holes for the passage and discharge of reaction gases is neither obvious for the skilled person nor has this particular arrangement been suggested by the prior art at hand for solving the problem of how to provide an effective thermal and water management.

4. Further remarks

4.1 **D2** (EP 1286404) is an intermediate document which might be relevant in an eventual regional phase. It discloses in paragraphs [0082]-[0093] and in Figures 15-17 and 20-23 a fuel cell having separator plates (14A) comprising coolant paths (S2) and air flow paths (S1), wherein through-holes (143) enable the coolant to be injected into said air flow path for cooling the fuel cell and humidifying the air stream.

4.2 Reference numeral (108) indicating the left-hand side portion of a fluid collection channel (see page 12, 4. paragraph) is lacking in the corresponding Figure 5b (and all other Figures).

4.3 First and second lower openings numerals **208b1** and **208b2** in the description (see page 13, last paragraph) are inconsistent with reference numerals **208a3** and **208a4**

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP 03/06327

in the corresponding Figures 7a and 7b.

- 4.4 Connecting side openings numeral 209 in the description (see page 17, line 9) is inconsistent with the reference numeral (215) in the corresponding Figure 8a.

INTERNATIONAL SEARCH REPORT

10/517982

International Application No.
PCT/EP 03/06327

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M8/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 998 054 A (JONES DANIEL O ET AL) 7 December 1999 (1999-12-07)	1-8
Y	column 5, line 11-14, 64-67 column 6, line 26-49 column 7, line 5-50 column 8, line 13-26 figures 2-4	9-13
X, P	EP 1 286 404 A (EQUOS RES KK) 26 February 2003 (2003-02-26) paragraphs '0082!-'0093! figures 15-17, 20-23	1-3, 5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex:

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the International filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the International filing date but later than the priority date claimed

- *T* later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *G* document member of the same patent family

Date of the actual completion of the International search

23 October 2003

Date of mailing of the International search report

03/11/2003

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Jacquinet, P

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/EP 03/06327

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00 70698 A (BRAMBILLA MASSIMO ;MAZZUCHELLI GABRIELE (IT); FLEBA GIAN PIERO (I) 23 November 2000 (2000-11-23) page 10, line 7-12; figure 4	9-13
A	page 11, line 13 -page 12, line 25 page 15, line 10 -page 16, line 12 examples 1-3	1-8, 14-28
A	WO 00 63992 A (BRAMBILLA MASSIMO ;MAZZUCHELLI GABRIELE (IT); NORA FUEL CELLS S P) 26 October 2000 (2000-10-26) cited in the application page 6, last line -page 7, line 16 page 10, line 8-21 examples 5-9	1-28
A	"PILES A COMBUSTIBLE A REFROIDISSEMENT INTEGRE" RESEARCH DISCLOSURE, KENNETH MASON PUBLICATIONS, HAMPSHIRE, GB, no. 430, February 2000 (2000-02), pages 254-255, XP000969027 ISSN: 0374-4353 the whole document	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.



PCT/EP 03/06327

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5998054	A	07-12-1999	AU 7132398 A WO 9905740 A1 US 6528198 B1	16-02-1999 04-02-1999 04-03-2003
EP 1286404	A	26-02-2003	JP 2003197217 A EP 1286404 A2 US 2003039875 A1	11-07-2003 26-02-2003 27-02-2003
WO 0070698	A	23-11-2000	IT MI991090 A1 AU 5213700 A BR 0010626 A CA 2368949 A1 CN 1351769 T WO 0070698 A1 EP 1181730 A1 JP 2003500802 T TW 456065 B	20-11-2000 05-12-2000 19-02-2002 23-11-2000 29-05-2002 23-11-2000 27-02-2002 07-01-2003 21-09-2001
WO 0063992	A	26-10-2000	IT MI990829 A1 AU 756163 B2 AU 4912900 A BR 0009888 A CA 2368895 A1 CN 1347575 T WO 0063992 A1 EP 1171926 A1 JP 2002542591 T TW 499779 B	23-10-2000 09-01-2003 02-11-2000 22-01-2002 26-10-2000 01-05-2002 26-10-2000 16-01-2002 10-12-2002 21-08-2002

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference M/44167-PCT		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEAA416)	
International application No. PCT/EP 03/06327	International filing date (day/month/year) 16.06.2003	Priority date (day/month/year) 17.06.2002	
International Patent Classification (IPC) or both national classification and IPC H01M8/04			
Applicant NUVERA FUEL CELLS EUROPE S.R.L. et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input checked="" type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 15.01.2004		Date of completion of this report 06.09.2004	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer Jacquinot, P Telephone No. +49 89 2399-7239 	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/06327**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-20 as originally filed

Claims, Numbers

1-28 as originally filed

Drawings, Sheets

1/10-10/10 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/06327**

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application,

☒ claims Nos. 28

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (specify):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 28 are so unclear that no meaningful opinion could be formed (*specify*):

see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos.

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the Standard.

☐ the computer readable form has not been furnished or does not comply with the Standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	9-26
	No: Claims	1-8,27
Inventive step (IS)	Yes: Claims	14-26
	No: Claims	9-13
Industrial applicability (IA)	Yes: Claims	1-26
	No: Claims	

2. Citations and explanations

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/06327**

see separate sheet

Re item III

1. Clarity

- 1.1 The subject-matter of **claim 28** is unclear under Article 6 PCT. A claim cannot be defined with the only characterizing part being a reference to drawings. As the aimed scope of protection is unclear, the assessment of novelty, inventive step and industrial applicability is not possible.

Re Item V

1. Considered documents

The following documents (D) are referred to in this communication; the numbering will be adhered to in the rest of the procedure:

- D1: US-A-5 998 054 (JONES DANIEL O ET AL) 7 December 1999 (1999-12-07)
D2: EP-A-1 286 404 (EQUOS RES KK) 26 February 2003 (2003-02-26)
D3: WO 00/70698 A (BRAMBILLA MASSIMO ;MAZZUCHELLI GABRIELE (IT);
FLEBA GIAN PIERO (I) 23 November 2000 (2000-11-23)

2. Novelty

The subject-matter of claims 1-8 and 27 appears not to satisfy the requirements of novelty according to Article 33(2) PCT:

- 2.1 **D1**(US 5998054) discloses in Figures 2-4 a PEM-FC system comprising separator plates (120) having aligned injection holes (131) for injecting liquid water from an input channel (140) into the reactant gas bearing gas flow channels (126) in order to humidify and implicitly also cooling the system. Carbon fabric serves as gas diffusion layer (reticulated element; column 5, lines 11-14). The diameter of the injection holes varies between 0.127-0.254 mm (column 5, line 64-67). The gasket (136) leaves a space for a fluid collection channel (134). Therefore, the subject-matter of **claims 1-8 and 27** is regarded as not being novel.

3. Inventive step

The subject-matter of claims 9-13 appears not to satisfy the requirements of inventiveness according to Article 33(3) PCT:

- 3.1 **D1** is regarded as the closest prior art with respect to claim 9. It differs from the present application insofar as a multiplicity of additional cells (101) is lacking. These additional cells serve for cooling the stack whilst preheating the water in order to effectively humidify the reactant gas. The problem to be solved might be formulated such as how to provide the thermal energy to the humidifying fluid for an evaporative humidification/cooling management. The solution, however, appears obvious for the skilled person in view of the teaching of **D3** (WO 0070698) which proposes the incorporation of devices (11) (see page 15, line 10 to page 16, line 12 and Figures 3-5) comprising electrically reticulated elements (5'), corresponding channels and openings between reaction cells. Furthermore, one or more water injection channels (15) are placed below feed openings (13) (see page 16, lines 7-12 and Figure 4). Therefore, the subject-matter of **claims 9-13** is regarded as lacking an inventive step.
- 3.2 The subject-matter of **claim 14** and its depending **claims 15-26**, however, is regarded as involving an inventive step, because a generator having conductive bipolar plates comprising the (known) multiplicity of fluid injection holes, further comprising a multiplicity of first and a multiplicity of second calibrated holes for the passage and discharge of reaction gases is neither obvious for the skilled person nor has this particular arrangement been suggested by the prior art at hand for solving the problem of how to provide an effective thermal and water management.

4. Further remarks

- 4.1 **D2** (EP 1286404) is an intermediate document which might be relevant in an eventual regional phase. It discloses in paragraphs [0082]-[0093] and in Figures 15-17 and 20-23 a fuel cell having separator plates (14A) comprising coolant paths (S2) and air flow paths (S1), wherein through-holes (143) enable the coolant to be injected into said air flow path for cooling the fuel cell and humidifying the air stream.
- 4.2 Reference numeral (108) indicating the left-hand side portion of a fluid collection channel (see page 12, 4. paragraph) is lacking in the corresponding Figure 5b (and all other Figures).
- 4.3 First and second lower openings numerals **208b1** and **208b2** in the description (see page 13, last paragraph) are inconsistent with reference numerals **208a3** and **208a4**.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP 03/06327

in the corresponding Figures 7a and 7b.

- 4.4 Connecting side openings numeral 209 in the description (see page 17, line 9) is inconsistent with the reference numeral (215) in the corresponding Figure 8a.

10/517982

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Dr. W. Kinzebach
Reitstötter, Kinzebach & Partner
(GbR)
Sternwartstrasse 4
D-81679 München
ALLEMAGNE

Patentanwälte
Reitstötter, Kinzebach & Part.

Eing. 07. Sep. 2004

Sternwartstr. 4 D-81679 München
PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT

(PCT Rule 71.1) ✓

Date of mailing
(day/month/year)

06.09.2004 ✓

Applicant's or agent's file reference
M/44167-PCT

IMPORTANT NOTIFICATION

International application No.
PCT/EP 03/06327

International filing date (day/month/year)
16.06.2003

Priority date (day/month/year)
17.06.2002

Applicant

NUVERA FUEL CELLS EUROPE S.R.L. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international
preliminary examining authority:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized Officer

Marchetto, L

Tel. +49 89 2399-2796



7.10.04

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ _____

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated).

For International Preliminary Examining Authority use only

Identification of IPEA		Date of receipt of DEMAND	
Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION		Applicant's or agent's file reference M/44167-PCT	
International application No. PCT/EP03/06327	International filing date (day/month/year) 16.06.2003	(Earliest) Priority date (day/month/year) 17.06.2002	
Title of invention Fuel cell with evaporative cooling and humidification			
Box No. II APPLICANT(S)			
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) Nuvera Fuel Cells Europe S.r.l. Via Bistolfi, 35 I-20134 Milano Italy		Telephone No.	
		Facsimile No.	
		Teleprinter No.	
		Applicant's registration No. with the Office	
State (that is, country) of nationality: IT		State (that is, country) of residence: IT	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) Trifoni, Eduardo Via Donizetti 5 80127 Napoli Italy			
State (that is, country) of nationality: IT		State (that is, country) of residence: IT	
Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.) FACCHI, Daniele Via S. Anna 17 25038 Rovato (BS) Italy			
State (that is, country) of nationality: IT		State (that is, country) of residence: IT	
<input checked="" type="checkbox"/> Further applicants are indicated on a continuation sheet.			

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

FLEBA, Gian Piero
Via F. Villa 6
20134 Milano
Italy

State (that is, country) of nationality:
IT

State (that is, country) of residence:
IT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

LENARDON, Matteo
Via Unione 2
22074 Lomazzo (Como)
Italy

State (that is, country) of nationality:
IT

State (that is, country) of residence:
IT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

LIOTTA, Marcello
Via della Cooperazione 117
20089 Rozzano (MI)
Italy

State (that is, country) of nationality:
IT

State (that is, country) of residence:
IT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

MERLO, Luca
Via Molera 12
22030 Montorfano (CO)
Italy

State (that is, country) of nationality:
IT

State (that is, country) of residence:
IT

☒ Further applicants are indicated on another continuation sheet.

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

JACOBO, Rubén Ornelas
Via Gorki 20
20098 San Giuliano Milanese (MI)
Italy

State *(that is, country)* of nationality:
IT

State *(that is, country)* of residence:
IT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

ANTONINO, Toro
Via Morandi 17
20090 Segrate
Italy

State *(that is, country)* of nationality:
IT

State *(that is, country)* of residence:
IT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

TRAINI, Fabio
Via Pisani Dossi 31
20134 Milano
Italy

State *(that is, country)* of nationality:
IT

State *(that is, country)* of residence:
IT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

☐ Further applicants are indicated on another continuation sheet.

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination.☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*Dr. W. Kinzebach
Reitstötter, Kinzebach & Partner (GbR)
Patentanwälte
Sternwartstr. 4
D - 81679 MünchenTelephone No.
089-99 83 970Facsimile No.
089-98 73 04

Teleprinter No.

Agent's registration No. with the Office

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***

1. The applicant wishes the international preliminary examination to start on the basis of:

☐ the international application as originally filedthe description ☐ as originally filed☐ as amended under Article 34the claims ☐ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34the drawings ☐ as originally filed☐ as amended under Article 342. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.3. ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69.1(d)). *(This check-box may be marked only where the time limit under Article 19 has not yet expired.)*

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English☒ which is the language in which the international application was filed.☐ which is the language of a translation furnished for the purposes of international search.☐ which is the language of publication of the international application.☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.**Box No. V ELECTION OF STATES**The applicant hereby elects all eligible States *(that is, all States which have been designated and which are bound by Chapter II of the PCT)*

excluding the following States which the applicant wishes not to elect:

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | |
|--|---|--------|
| 1. translation of international application | : | sheets |
| 2. amendments under Article 34 | : | sheets |
| 3. copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4. copy (or, where required, translation) of statement under Article 19 | : | sheets |
| 5. letter | : | sheets |
| 6. other (<i>specify</i>) : | : | sheets |

For International Preliminary
Examining Authority use only

received	not received
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<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- | | |
|---|--|
| 1. <input checked="" type="checkbox"/> fee calculation sheet | 5. <input type="checkbox"/> statement explaining lack of signature |
| 2. <input type="checkbox"/> original separate power of attorney | 6. <input type="checkbox"/> sequence listing in computer readable form |
| 3. <input type="checkbox"/> original general power of attorney | 7. <input type="checkbox"/> other (<i>specify</i>): |
| 4. <input type="checkbox"/> copy of general power of attorney;
reference number, if any: | |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

Munich, January 15, 2004


J. Uwe Müller, Patent Attorney

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:
2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):
3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply. ☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:



REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

10/517982

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum) M/44167-PCT

Box No. I TITLE OF INVENTION Membrane electrochemical generator	
Box No. II APPLICANT <input type="checkbox"/> This person is also inventor.	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i>	
NUVERA FUEL CELLS EUROPE S.R.L. Via Bistolfi, 35 I-20134 Milano Italy	
Telephone No.	
Facsimile No.	
Teleprinter No.	
Applicant's registration No. with the Office	
State <i>(that is, country)</i> of nationality: IT	State <i>(that is, country)</i> of residence: IT
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input checked="" type="checkbox"/> all designated States except the United States of America <input type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i>	
TRIFONI, Eduardo Via Donizetti 5 80127 Napoli Italy	
This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
Applicant's registration No. with the Office	
State <i>(that is, country)</i> of nationality: IT	State <i>(that is, country)</i> of residence: IT
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box	
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on a continuation sheet.	
Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE	
The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: <input checked="" type="checkbox"/> agent <input type="checkbox"/> common representative	
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)</i>	
Dr. W. Kinzebach Reitstötter, Kinzebach & Partner (GbR) Patentanwälte Sternwartstraße 4 D - 81679 München	
Telephone No. 089-99 83 970	
Facsimile No. 089-98 73 04	
Teleprinter No.	
Agent's registration No. with the Office	
<input type="checkbox"/> Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.	

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)			
<i>If none of the following sub-boxes is used, this sheet should not be included in the request.</i>			
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> FACCHI, Daniele Via S. Anna 17 25038 Rovato (BS) Italy		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
State <i>(that is, country)</i> of nationality: IT		State <i>(that is, country)</i> of residence: IT	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> FLEBA, Gian Piero Via F. Villa 6 20134 Milano Italy		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
State <i>(that is, country)</i> of nationality: IT		State <i>(that is, country)</i> of residence: IT	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> LENARDON, Matteo Via Unione 2 22074 Lomazzo (Como) Italy		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
State <i>(that is, country)</i> of nationality: IT		State <i>(that is, country)</i> of residence: IT	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
Name and address: <i>(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)</i> LIOTTA, Marcello Via della Cooperazione 117 20089 Rozzano (MI) Italy		This person is: <input type="checkbox"/> applicant only <input checked="" type="checkbox"/> applicant and inventor <input type="checkbox"/> inventor only <i>(If this check-box is marked, do not fill in below.)</i>	
State <i>(that is, country)</i> of nationality: IT		State <i>(that is, country)</i> of residence: IT	
This person is applicant for the purposes of: <input type="checkbox"/> all designated States <input type="checkbox"/> all designated States except the United States of America <input checked="" type="checkbox"/> the United States of America only <input type="checkbox"/> the States indicated in the Supplemental Box			
<input checked="" type="checkbox"/> Further applicants and/or (further) inventors are indicated on another continuation sheet.			

Continuation of Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

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MERLO, Luca
Via Molera 12
22030 Montorfano (CO)
Italy

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

State (that is, country) of nationality:
IT

State (that is, country) of residence:
IT

This person is applicant for the purposes of:

- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

JACOBO, Rubén Ornelas
Via Gorki 20
20098 San Giuliano Milanese (MI)
Italy

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

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ANTONINO, Toro
Via Marazzani 12
20132 Milano
Italy

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

State (that is, country) of nationality:
IT

State (that is, country) of residence:
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TRAINI, Fabio
Via Pisani Dossi 31
20134 Milano
Italy

This person is:

- ☐ applicant only
☒ applicant and inventor
☐ inventor only (If this check-box is marked, do not fill in below.)

Applicant's registration No. with the Office

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- ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Feld Nr. V BESTIMMUNG VON STAATEN

Bitte die entsprechenden Kästchen ankreuzen; wenigstens ein Kästchen muß angekreuzt werden.

Die folgenden Bestimmungen nach Regel 4.9 Absatz a werden hiermit vorgenommen:

Regionales Patent

- ☒ **AP** ARIPO-Patent: GH Ghana, GM Gambia, KE Kenia, LS Lesotho, MW Malawi, MZ Mosambik, SD Sudan, SL Sierra Leone, SZ Swasiland, TZ Vereinigte Republik Tansania, UG Uganda, ZM Sambia, ZW Simbabwe und jeder weitere Staat, der Vertragsstaat des Harare-Protokolls und des PCT ist (falls eine andere Schutzrechtsart oder ein sonstiges Verfahren gewünscht wird, bitte auf der gepunkteten Linie angeben)
- ☒ **EA** Eurasisches Patent: AM Armenien, AZ Aserbaidshan, BY Belarus, KG Kirgisistan, KZ Kasachstan, MD Republik Moldau, RU Russische Föderation, TJ Tadschikistan, TM Turkmenistan und jeder weitere Staat, der Vertragsstaat des Eurasischen Patentübereinkommens und des PCT ist
- ☒ **EP** Europäisches Patent: AT Österreich, BE Belgien, BG Bulgarien, CH & LI Schweiz und Liechtenstein, CY Zypern, CZ Tschechische Republik, DE Deutschland, DK Dänemark, EE Estland, ES Spanien, FI Finnland, FR Frankreich, GB Vereinigtes Königreich, GR Griechenland, IE Irland, IT Italien, LU Luxemburg, MC Monaco, NL Niederlande, PT Portugal, SE Schweden, SI Slowenien, SK Slowakei, TR Türkei und jeder weitere Staat, der Vertragsstaat des Europäischen Patentübereinkommens und des PCT ist RO, HU
- ☒ **OA** OAPI-Patent: BF Burkina Faso, BJ Benin, CF Zentralafrikanische Republik, CG Kongo, CI Côte d'Ivoire, CM Kamerun, GA Gabun, GN Guinea, GQ Äquatorialguinea, GW Guinea-Bissau, ML Mali, MR Mauretanien, NE Niger, SN Senegal, TD Tschad, TG Togo und jeder weitere Staat, der Vertragsstaat der OAPI und des PCT ist (falls eine andere Schutzrechtsart oder ein sonstiges Verfahren gewünscht wird, bitte auf der gepunkteten Linie angeben)

Nationales Patent (falls eine andere Schutzrechtsart oder ein sonstiges Verfahren gewünscht wird, bitte auf der gepunkteten Linie angeben):

- | | | |
|---|--|---|
| <input checked="" type="checkbox"/> AE Vereinigte Arabische Emirate | <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> NZ Neuseeland |
| <input checked="" type="checkbox"/> AG Antigua und Barbuda | <input checked="" type="checkbox"/> HR Kroatien | <input checked="" type="checkbox"/> OM Oman |
| <input checked="" type="checkbox"/> AL Albanien | <input checked="" type="checkbox"/> HU Ungarn | <input checked="" type="checkbox"/> PH Philippinen |
| <input checked="" type="checkbox"/> AM Armenien | <input checked="" type="checkbox"/> ID Indonesien | <input checked="" type="checkbox"/> PL Polen |
| <input checked="" type="checkbox"/> AT Österreich | <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> AU Australien | <input checked="" type="checkbox"/> IN Indien | <input checked="" type="checkbox"/> RO Rumänien |
| <input checked="" type="checkbox"/> AZ Aserbaidshan | <input checked="" type="checkbox"/> IS Island | <input checked="" type="checkbox"/> RU Russische Föderation |
| <input checked="" type="checkbox"/> BA Bosnien-Herzegowina | <input checked="" type="checkbox"/> JP Japan | |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> KE Kenia | <input checked="" type="checkbox"/> SC Seychellen |
| <input checked="" type="checkbox"/> BG Bulgarien | <input checked="" type="checkbox"/> KG Kirgisistan | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> BR Brasilien | <input checked="" type="checkbox"/> KP Demokratische Volksrepublik Korea | <input checked="" type="checkbox"/> SE Schweden |
| <input checked="" type="checkbox"/> BY Belarus | | <input checked="" type="checkbox"/> SG Singapur |
| <input checked="" type="checkbox"/> BZ Belize | <input checked="" type="checkbox"/> KR Republik Korea | <input checked="" type="checkbox"/> SK Slowakei |
| <input checked="" type="checkbox"/> CA Kanada | <input checked="" type="checkbox"/> KZ Kasachstan | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> CH & LI Schweiz und Liechtenstein | <input checked="" type="checkbox"/> LC Saint Lucia | <input checked="" type="checkbox"/> TJ Tadschikistan |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> LK Sri Lanka | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> CO Kolumbien | <input checked="" type="checkbox"/> LR Liberia | <input checked="" type="checkbox"/> TN Tunesien |
| <input checked="" type="checkbox"/> CR Costa Rica | <input checked="" type="checkbox"/> LS Lesotho | <input checked="" type="checkbox"/> TR Türkei |
| <input checked="" type="checkbox"/> CU Kuba | <input checked="" type="checkbox"/> LT Litauen | <input checked="" type="checkbox"/> TT Trinidad und Tobago |
| <input checked="" type="checkbox"/> CZ Tschechische Republik | <input checked="" type="checkbox"/> LU Luxemburg | |
| <input checked="" type="checkbox"/> DE Deutschland | <input checked="" type="checkbox"/> LV Lettland | <input checked="" type="checkbox"/> TZ Vereinigte Republik Tansania |
| <input checked="" type="checkbox"/> DK Dänemark | <input checked="" type="checkbox"/> MA Marokko | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> DM Dominica | <input checked="" type="checkbox"/> MD Republik Moldau | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> DZ Algerien | | <input checked="" type="checkbox"/> US Vereinigte Staaten von Amerika |
| <input checked="" type="checkbox"/> EC Ecuador | <input checked="" type="checkbox"/> MG Madagaskar | |
| <input checked="" type="checkbox"/> EE Estland | <input checked="" type="checkbox"/> MK Die ehemalige jugoslawische Republik Mazedonien | <input checked="" type="checkbox"/> UZ Usbekistan |
| <input checked="" type="checkbox"/> ES Spanien | <input checked="" type="checkbox"/> MN Mongolei | <input checked="" type="checkbox"/> VC St. Vincent und die Grenadinen |
| <input checked="" type="checkbox"/> FI Finnland | <input checked="" type="checkbox"/> MW Malawi | <input checked="" type="checkbox"/> VN Vietnam |
| <input checked="" type="checkbox"/> GB Vereinigtes Königreich | <input checked="" type="checkbox"/> MX Mexiko | <input checked="" type="checkbox"/> YU Jugoslawien |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> MZ Mosambik | <input checked="" type="checkbox"/> ZA Südafrika |
| <input checked="" type="checkbox"/> GE Georgien | <input checked="" type="checkbox"/> NO Norwegen | <input checked="" type="checkbox"/> ZM Sambia |
| <input checked="" type="checkbox"/> GH Ghana | | <input checked="" type="checkbox"/> ZW Simbabwe |

Kästchen für die Bestimmung von Staaten, die dem PCT nach der Veröffentlichung dieses Formblatts beigetreten sind.

- | | | |
|--|--------------------------|--------------------------|
| <input checked="" type="checkbox"/> NI Nicaragua | <input type="checkbox"/> | <input type="checkbox"/> |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Erklärung bzgl. vorsorglicher Bestimmungen: Zusätzlich zu den oben genannten Bestimmungen nimmt der Anmelder nach Regel 4.9 Absatz b auch alle anderen nach dem PCT zulässigen Bestimmungen vor mit Ausnahme der im Zusatzfeld genannten Bestimmungen, die von dieser Erklärung ausgenommen sind. Der Anmelder erklärt, daß diese zusätzlichen Bestimmungen unter dem Vorbehalt einer Bestätigung stehen und jede zusätzliche Bestimmung, die vor Ablauf von 15 Monaten ab dem Prioritätsdatum nicht bestätigt wurde, nach Ablauf dieser Frist als vom Anmelder zurückgenommen gilt. (Die Bestätigung (einschließlich der Gebühren) muß beim Anmeldeamt innerhalb der Frist von 15 Monaten eingehen.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application:* regional Office	international application: receiving Office
item (1) 17.06.2002	MI2002A 001338	Italy		
item (2)				
item (3)				
item (4)				
item (5)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office) identified above as:

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Box No. VIII DECLARATIONS

The following declarations are contained in Boxes Nos. VIII (i) to (v) (mark the applicable check-boxes below and indicate in the right column the number of each type of declaration):

Number of
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- | | | |
|---|--|---|
| <input type="checkbox"/> Box No. VIII (i) | Declaration as to the identity of the inventor | : |
| <input type="checkbox"/> Box No. VIII (ii) | Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent | : |
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| <input type="checkbox"/> Box No. VIII (v) | Declaration as to non-prejudicial disclosures or exceptions to lack of novelty | : |

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application contains:

(a) the following number of sheets in paper form:

request (including declaration sheets) : 6
 description (excluding sequence listing part) : 20
 claims : 8
 abstract : 1
 drawings : 10

Sub-total number of sheets : 45

sequence listing part of description (actual number of sheets if filed in paper form, whether or not also filed in computer readable form; see (b) below) :

Total number of sheets : 45

(b) sequence listing part of description filed in computer readable form

(i) ☐ only (under Section 801(a)(i))(ii) ☐ in addition to being filed in paper form (under Section 801(a)(ii))

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which the sequence listing part is contained (additional copies to be indicated under item 9(ii), in right column):

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Figure of the drawings which should accompany the abstract: 2 + 7a

Language of filing of the international application: englisch

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).



Munich, June 16, 2003

J. Uwe Müller, Patent Attorney

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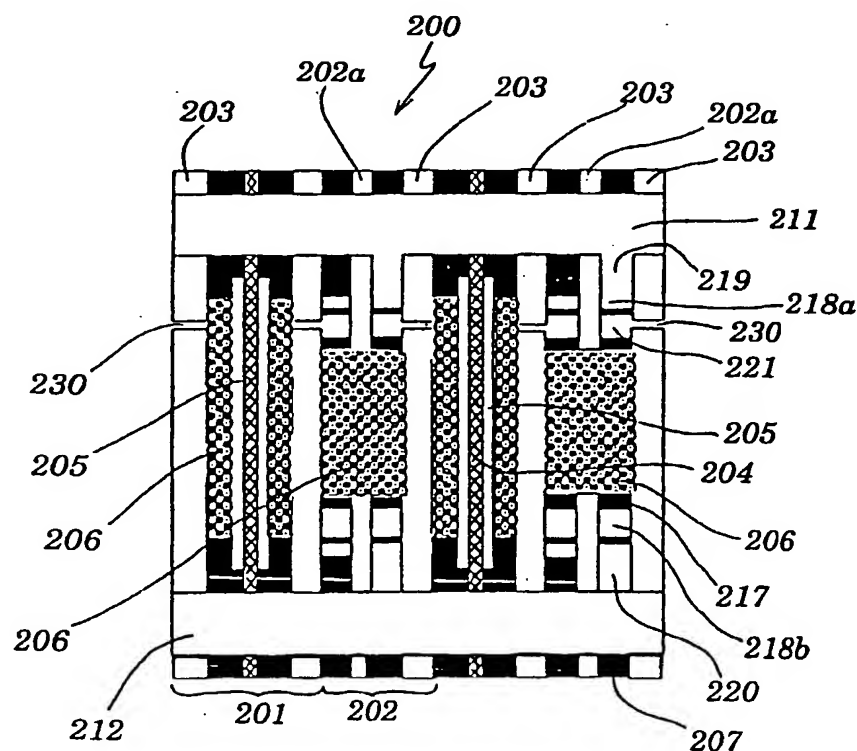
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[Continued on next page]

(54) Title: **FUEL CELL WITH EVAPORATIVE COOLING AND HUMIDIFICATION**



(57) Abstract: The present invention relates to a membrane electrochemical generator (200) formed by a multiplicity of reaction cells (201) mutually connected in electrical series and assembled according to a bipolar configuration. In accordance with the present invention, the thermal management of the membrane electrochemical generator (200) and the hydration of the membrane (204) are ensured by the injection of a cooling fluid, preferably liquid water, in the gaseous reactant feed. Such an injection takes place through a multiplicity of calibrated fluid injection holes (230) obtained in conductive bipolar plates (203) delimiting the reaction files (201). The cooling fluid can be preheated by passing through a collector/distributor structure (206) located in an additional cell (202).

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MEMBRANE ELECTROCHEMICAL GENERATOR

DESCRIPTION OF THE INVENTION

The present invention relates to a membrane electrochemical generator with direct injection of liquid water into the gaseous reactants.

Processes of conversion of chemical energy to electric energy based on membrane electrochemical generators are known in the art.

In general, a membrane electrochemical generator is formed by a multiplicity of reaction cells mutually connected in electrical series and assembled according to a bipolar configuration.

Each reaction cell converts the chemical energy generated during the reaction of a fuel with an oxidant without degrading it completely to thermal energy, and therefore without being subject to the limitations of Carnot's cycle. More specifically, the fuel is supplied to the anodic chamber of the reaction cell and consists for instance of a hydrogen-rich gaseous mixture or of solutions of light alcohols, such as methanol or ethanol, while the oxidant is supplied to the cathodic chamber of the same cell and consists for instance of air or oxygen.

The fuel is catalytically electro-oxidised in the anodic chamber releasing protons H^+ and electrons e^- which are consumed in the cathodic chamber through a catalytic reaction of oxidant electro-reduction, with production of water. A proton-exchange membrane which separates the anodic and the cathodic chamber allows the continuous flow of protons H^+ from the anodic chamber to

the cathodic chamber while simultaneously hindering the passage of electrons e^- , which conversely takes place through an external electric circuit. In this way, the difference of electric potential established at the poles of the reaction cell is maximised.

The proton-exchange membranes commonly employed in membrane electrochemical generators consist of a chemically inert polymer, partially functionalised with groups capable of undergoing an acid-base hydrolysis in the presence of liquid water, with consequent separation of electrical charge. More precisely, the above hydrolysis consists of the release of positive ions (cations) and the formation of fixed negative charges on the polymer.

In order to maintain the proton-exchange membranes constantly hydrated so as to allow the hydrolysis and thus the separation of electrical charge permitting the protonic conduction to take place, the gaseous reactants (fuel and oxidant) are supplied to the electrochemical generator saturated with water vapour and at a temperature close to that of the reaction cells by means of expensive and complex saturation devices, placed outside the electrochemical generator itself.

The known electrochemical generators are also provided with suitable cooling devices which accomplish the withdrawal of the heat produced during the functioning of the generator itself, through thermal exchange with a circulating fluid (for instance deionised water). The heat must be efficiently withdrawn from the electrochemical generator to allow the thermal control thereof not only due to the limited thermal stability of the proton-exchange

membranes, usually unfit for operating at temperatures above 100°C, but also to limit as far as possible the evaporation of the water produced in the course of the electro-reduction reaction and its consequent removal by the flow of inerts and unconverted reactants exiting the generator, with the consequent risk of membrane dry-out.

Nevertheless, the presence of these cooling devices renders the known electrochemical generators even more complex and expensive.

A known solution to prevent these inconveniences is disclosed in the international patent application WO 00/63992 to the same applicant, providing the direct injection of a calibrated flow of liquid water in a membrane electrochemical generator consisting of reaction cells having a reticulated material, of the type disclosed in US Patent 5,482,792, placed inside the anodic and cathodic chambers. The calibrated flow of liquid water, partially evaporating within the reticulated element taking advantage of the elevated surface development, simultaneously provides to humidifying the gaseous reactants while thermally controlling the electrochemical generator without making use of two distinct devices and thus limiting the costs and the complexity of the generator itself.

The above described solution, while being advantageous under many aspects, nonetheless presents a few inconveniences.

In particular, the direct injection of the calibrated flow of liquid water takes place peripherally to the active area of each reaction cell and transversally to the flow of gaseous reactants. Such a mode for direct injection of liquid water, due to

the reduced momentum of the latter and to the adhesion phenomena to the walls of the sealing gaskets, may determine a non uniform distribution of water within the active area of each cell, with consequent formation of non moistened, hot and incipiently drying regions. This has the effect of provoking the membrane drying-out and thus the reduction of their operative lifetime besides hampering the mechanism of water evaporation, with consequent increment of the liquid water flow-rate necessary to the thermal control of the electrochemical generator.

The object of the present invention is to provide a membrane electrochemical generator free of the described drawbacks.

According to the present invention, a membrane electrochemical generator is realised as defined in claim 1.

For a better understanding of the invention, an embodiment thereof is described below, as a mere non limiting example and making reference to the attached drawings, wherein:

- figure 1 shows an exploded side-view of a first embodiment of a membrane electrochemical generator according to the invention;
- figure 2 shows a front-view of a component of the membrane electrochemical generator of figure 1;
- figures 3a, 3b, 3c show front-views of embodiments of further components of the membrane electrochemical generator of figure 1;
- figure 4 shows an exploded side-view of a second embodiment of a membrane electrochemical generator according to the invention;

- figures 5a, 5b show front-views of two different embodiments of a component of the electrochemical generator of figure 4;
- figure 6 shows a side-view of a portion of a third embodiment of a membrane electrochemical generator according to the invention;
- figures 7a, 7b show front-views of a component of the electrochemical generator of figure 6;
- figures 8a, 8b show front-views of a further component of the electrochemical generator of figure 6;
- figures 9a, 9b show front-views of a different embodiment of the component shown in figures 8a and 8b;
- figures 10a, 10b show front-views of a different embodiment of the component shown in figures 7a and 7b;
- figures 11a, 11b show front-views of a different embodiment of the component shown in figures 8a and 8b; and
- figures 12a, 12b show front-views of a different embodiment of the component shown in figures 9a and 9b.

Figure 1 shows a first embodiment of a membrane electrochemical generator according to the invention. The electrochemical generator 1 comprises a multiplicity of reaction cells 2 mutually connected in series and assembled according to a filter-press type configuration.

More in detail, each reaction cell 2 is delimited by a pair of conductive bipolar plates 3, with planar faces, among which are comprised, proceeding outwards, the proton-exchange membrane 4; a pair of porous electrodes 5; a

pair of catalytic layers 6 deposited at the interface between membrane 4 and each of the porous electrodes 5; a pair of current collectors/distributors 7, realised by means of a reticulated metallic element of the type described in US Patent 5,482,792, electrically connecting the conductive bipolar plates 3 to the porous electrodes 5 while simultaneously distributing the gaseous reactants; a sealing gasket pair 8a, 8b consisting of an anodic sealing gasket 8a and a cathodic sealing gasket 8b. The anodic sealing gasket 8a is directed to seal the periphery of the anodic chamber 9 of the reaction cell 2 in order to avoid the leakage of fuel (hydrogen in particular), while the cathodic sealing gasket 8b is directed to seal the periphery of the cathodic chamber 10 of the reaction cell 2 in order to avoid the leakage of oxidant (air in particular). The anodic and cathodic sealing gaskets 8a, 8b are also directed to realise the seat for the current collectors/distributors 7.

As shown in figure 2, the conductive bipolar plates 3 have a substantially rectangular shape and each of them presents a perimetrical portion 11 provided with: first and second upper openings 12, 13 for the passage of the gaseous reactants, respectively fuel and oxidant; first and second lower openings 14, 15 for the discharge of the reaction products mixed with the optional residual reactants; side openings 16 for the passage of a cooling fluid, in particular liquid water. The perimetrical portion 11 is also provided with a multiplicity of holes 17 for the housing of tie-rods by means of which the tightening of the electrochemical generator 1 is accomplished.

During the assemblage of the electrochemical generator 1, the coupling between the first and the second upper openings 12, 13 of all the conductive bipolar plates 3 determines the formation of two upper longitudinal ducts 18 while the coupling between the first and the second lower openings 14, 15 of all the conductive bipolar plates 3 determines the formation of two lower longitudinal ducts 19. The two upper longitudinal ducts 18, only one of which is shown in figure 1, define the feeding manifolds of the gaseous reactants while the two lower longitudinal ducts 19, only one of which is shown in figure 1, define the discharge manifolds of the reaction products mixed with the optional residual reactants. Alternatively, the lower longitudinal ducts 19 can be employed as feeding manifolds, and the upper longitudinal ducts 18 as discharge manifolds. It is also possible to feed one of the two gaseous reactants through one of the upper longitudinal ducts 18, using the corresponding lower longitudinal duct 19 for the discharge and feeding the other gaseous reactant through the other lower longitudinal duct 19 using the corresponding upper longitudinal duct 18 for the discharge.

Moreover, the coupling between the side openings 16 of all the conductive bipolar plates 3 determines the formation of side ducts, not shown in figure 1, for the passage of the liquid water.

Each conductive bipolar plate 3 is also provided with a multiplicity of fluid injection calibrated holes 20, all having the same diameter (for instance comprised between 0,2 mm ÷ 1 mm), through which the liquid water flowing in the side ducts of the electrochemical generator 1 is injected into the reaction

cells 2, as will be better explained hereafter. The fluid injection calibrated holes 20 are mutually aligned in order to ensure a homogeneous distribution of the liquid water and are placed below the first and second upper openings 12, 13.

As shown in figures 3a, 3b, 3c the anodic and cathodic sealing gaskets 8a, 8b of each reaction cell 2 have a substantially rectangular shape and present respective first and second upper openings 8a₁, 8a₂, 8b₁, 8b₂, for the passage of the gaseous reactants; respective first and second lower openings 8a₃, 8a₄, 8b₃, 8b₄, for the discharge of the reaction products mixed with the optional residual reactants; respective side openings 8a₅, 8b₅ for the passage of liquid water.

More in detail, the first upper openings 8a₁ (through which the fuel passes) and the second lower openings 8a₄ of the anodic gasket 8a are connected to the anodic chamber 9 through, respectively, distribution channels 21a and discharge channels 21b, obtained within the thickness of the same anodic sealing gasket (figure 3a). In their turn, the second upper openings 8b₂ (through which the oxidant passes) and the first lower openings 8b₃ of the cathodic sealing gasket 8b are connected to the cathodic chamber 10 respectively through the distribution channels 23a and the discharge channels 23b, obtained within the thickness of the same cathodic sealing gasket (figure 3b). The distributing and discharge channels 21a, 21b, 23a and 23b have a comb-like structure allowing them to distribute and collect within each reaction cell 2 the gaseous reactants and the reaction products, the latter mixed with the optional residual reactants, in a uniform fashion. The anodic sealing gasket 8a is

also provided with fluid collection channels 22 connected with the side openings 8a₅. Optionally, the fluid collection channels 22 can also be connected to the distribution channels 21a (figure 3c).

In a filter-press configuration, the first and the second upper openings 8a₁, 8a₂, 8b₁, 8b₂ of the anodic and cathodic sealing gaskets 8a, 8b form, in conjunction with the first and the second upper openings 12, 13 of the conductive bipolar plates 3 the two upper longitudinal ducts 18; the first and the second lower openings 8a₃, 8a₄, 8b₃, 8b₄ of the anodic and cathodic sealing gaskets 8a, 8b form, in conjunction with the first and the second lower openings 14, 15 of the conductive bipolar plates 3 the two lower longitudinal ducts 19; the side openings 8a₅, 8b₅ of the anodic and cathodic sealing gaskets 8a, 8b form, in conjunction with the side openings 16 of the conductive bipolar plates 3 the side ducts for the liquid water feed.

Moreover, in a filter-press configuration, the fluid collection channels 22 with which the anodic sealing gasket 8a is provided are placed in correspondence of the fluid injection calibrated holes 20 which in their turn are placed each in correspondence of a distribution channel 23a of the cathodic sealing gasket 8b.

The anodic and cathodic sealing gaskets 8a, 8b are also provided with a multiplicity of holes 24 for housing the tie-rods by means of which the tightening of the electrochemical generator 1 is accomplished.

In its turn, the electrochemical generator 1 is delimited by two conductive terminal plates 25 (figure 1), one of which is provided with nozzles, not shown in

figure 1, for the hydraulic connection of the upper and lower longitudinal ducts 18 and 19 and of the side ducts. Furthermore, both the conductive terminal plates 25 are provided with appropriate holes (also not shown in figure 1) for housing the tie-rods.

Operatively, the flow of liquid water supplied through the side ducts of the electrochemical generator 1 flows in the fluid collection channels 22 of the anodic sealing gaskets 8a and from here, through the fluid injection calibrated holes 20, is injected in the cathodic reactive streams entering the adjacent reaction cells 2.

As an alternative, if the anodic sealing gaskets 8a have a structure equivalent to the one shown in figure 3b and the cathodic sealing gaskets 8b 8a have a structure equivalent to the one shown in figure 3a the stream of liquid water flows in the fluid collection channels 22, in this case obtained within the cathodic sealing gaskets 8b, and from here, through the fluid injection calibrated holes 20, is injected in the anodic reactive streams entering the adjacent reaction cells 2.

In both cases, the thermal management of the electrochemical generator 1 and the humidification of the membrane 4 are performed by the evaporation of the liquid water flow across the reticulated metallic element which realises the current collector/distributor 7.

In figure 4, wherein the equivalent parts to those already illustrated making reference to figures 1, 2 and 3 have been provided with the same reference numerals, a second embodiment of membrane electrochemical

generator according to the invention is shown. The electrochemical generator 100 is entirely similar to the electrochemical generator 1 except that it comprises a multiplicity of additional cells 101, interposed between the reaction cells 2 in a 1:1 ratio.

Making reference to figure 5a, the additional cells 101 have a substantially rectangular shape and dimensions equivalent to those of the reaction cells 2 and each comprises a perimetrical portion 102a, acting as the separating surface for the two gaseous reactants and a hollow central portion 102b to realise the seat of the current collector/distributor 7. The perimetrical portion 102a is provided with first and second upper openings 103a₁, 103a₂, first and second lower openings 103b₁, 103b₂ and side openings 104 placed in correspondence of the first and second upper openings 103a₁, 103a₂.

In a filter-press configuration, the first and the second upper openings 103a₁, 103a₂ of the additional cells 101 form, in conjunction with the first and the second upper openings 8a₁, 8a₂, 8b₁, 8b₂ of the anodic and cathodic sealing gaskets 8a, 8b which, in this case, have the same structure equivalent to that shown in figure 3b, and with the first and the second upper openings 12, 13 of the conductive bipolar plates 3, the two upper longitudinal ducts 18; the first and the second lower openings 103b₁, 103b₂ of the additional cells 101 form, in conjunction with the first and the second lower openings 8a₃, 8a₄, 8b₃, 8b₄ of the anodic and cathodic sealing gaskets 8a, 8b and with the first and the second lower openings 14, 15 of the conductive bipolar plates 3, the two lower longitudinal ducts 19. In their turn, the side openings 104 of the additional cells

101 form, in conjunction with the side openings 8a₅, 8b₅ of the anodic and cathodic sealing gaskets 8a, 8b and with the side openings 16 of the conductive bipolar plates 3 the side feeding ducts of the liquid water. The perimetrical portion 102a is also provided with a multiplicity of holes 105 for housing the tie-rods.

Furthermore, on both faces of the perimetrical portion 102a a fluid collection channel 106 is present, connected to the side openings 104 and positioned below the first and second upper openings 103a₁, 103a₂. In a filter-press configuration, the fluid collection channel 106 is in correspondence of the fluid injection calibrated holes 20 of the conductive bipolar plates 3.

Operatively, the stream of liquid water supplied through the side ducts of the electrochemical generator 100 flows in the fluid collection channel 106 and from here, through the fluid injection calibrated holes 20, is injected in the reactant streams entering the adjacent reaction cells 2.

As an alternative, the fluid collection channel 106 may be formed by two side portions 107, 108, connected with the side openings 104, the latter being obtained in correspondence of the first and second lower openings 103b₁, 103b₂ (figure 5b).

In this case, the stream of liquid water, prior to reaching the fluid injection calibrated holes 20 and being injected into the reaction cells 2, enters the two side portions 107, 108 of the fluid collection channel 106 to subsequently cross the whole surface of the current collector/distributor 7 of the additional cell 101 pre-heating counter-currently or concurrently with respect to at least one of the

reactant flows entering the reaction cells 2. In this way, the additional cells 101 acts as cooling cells of the electrochemical generator 100.

Figure 6 shows a cross-section of a third embodiment, according to the invention, of a membrane electrochemical generator. The electrochemical generator 200, only a portion of which is shown in figure 6, is formed by a multiplicity of reaction cells 201 and of additional cells 202 mutually connected in series and assembled according to a filter-press type configuration; each additional cell 202 being interposed between a pair of reaction cells 201.

More in detail, each reaction cell 201 is delimited by a pair of flat-face conductive bipolar plates 203 among which are comprised, proceeding outwards, a proton-exchange membrane 204; a pair of porous electrodes 205; a pair of current collector/distributors 206 electrically connecting the conductive bipolar plates 203 to the porous electrodes 205; a pair of sealing gaskets 207 directed to seal the periphery of the reaction cell 201 in order to avoid the leakage of the gaseous reactants.

The conductive bipolar plates 203, shown in figures 7a, 7b, have a substantially rectangular shape and a typical thickness of $0,1\div 0,4$ mm. They present a perimetrical portion 208 provided with first and second upper openings 208a₁, 208a₂, first and second lower openings 208b₁, 208b₂ and side openings 209. The perimetrical portion 208 is also provided with a multiplicity of holes 210 for housing the tie-rods by means of which the tightening of the electrochemical generator 200 is achieved.

During the assemblage of the electrochemical generator 200, the coupling between the first and the second upper openings 208a₁, 208a₂ of all the conductive bipolar plates 203 determines the formation of two upper longitudinal ducts 211 while the coupling between the first and the second lower openings 208b₁, 208b₂ of all the conductive bipolar plates 203 determines the formation of two lower longitudinal ducts 212. The two upper longitudinal ducts 211, only one of which is shown in figure 6, define the feeding manifolds of the gaseous reactants (fuel and oxidant) while the two lower longitudinal ducts 212, only one of which is shown in figure 6, define the discharge manifolds of the reaction products mixed with the optional residual reactants. As an alternative, the lower longitudinal ducts 212 may be employed as feeding manifolds, and the upper longitudinal ducts 211 as discharge manifolds. It is also possible to feed one of the two gaseous reactants through one of the upper longitudinal ducts 211, using the correspondent lower longitudinal duct 212 for the discharge and feeding the other gaseous reactant through the other lower longitudinal duct 212 using the correspondent upper longitudinal duct 211 for the discharge.

Moreover, the coupling between the side openings 209 of all the conductive bipolar plates 203 determines the formation of side ducts, not shown in figure 6, for the passage of liquid water.

As shown in figure 7b, the sealing gaskets 207 are laid on just one face of each conductive bipolar plate 203 by (injection or compression) moulding, mechanical anchoring or gluing. They realise the seat of the current

collector/distributors 206 besides delimiting the active area of the reaction cells 201.

In particular, the sealing gaskets 207 are obtained with a soft material, for instance silicone, elastomer, etc, and present a final thickness which can range from some tenth of a millimetre to a few millimetres.

Each conductive bipolar plate 203 is also provided with a multiplicity of upper calibrated holes 213a and of a multiplicity of lower calibrated holes 213b of diameter comprised between 0,1 mm ÷ 5 mm. Through the multiplicity of upper calibrated holes 213a the gaseous reactants coming from the adjacent additional cell 202 flow, while through the multiplicity of lower calibrated holes 213b the reaction products and the residual reactants exit the reaction cell 201, as will be explained more in detail hereafter. The upper calibrated holes 213a are mutually aligned in order to ensure a homogeneous distribution of the gaseous reactants and are placed below the first and second upper openings 208a₁, 208a₂. In their turn, the lower calibrated holes 213b are mutually aligned and are placed above the first and second lower openings 208b₁, 208b₂. Both the upper 213a and lower 213b calibrated holes are spaced from the sealing gasket 207 by about 1 mm for better exploiting the active area of the reaction cell 201.

Furthermore, each conductive bipolar plate 203 is provided with a multiplicity of fluid injection calibrated holes 230, all having the same diameter (for example comprised between 0,2 mm ÷ 1 mm), through which the liquid water coming from the adjacent additional cell 202 is injected into the reaction cell 201. The fluid injection calibrated holes 230 are mutually aligned in order to ensure a

homogeneous distribution of liquid water and are placed below the upper calibrated holes 213a.

Making now reference to figures 8a, 8b, each additional cell 202 has a substantially rectangular shape and dimensions equivalent to those of the reaction cell 201. Each additional cell 202 comprises a rigid perimetrical portion 202a, made of plastic or metal, acting as the separating surface for the two gaseous reactants and a hollow central portion 202b to realise the seat of the current collector/distributor 206. The rigid perimetrical portion 202a is provided with first and second upper openings 214a₁, 214a₂, first and second lower openings 214b₁, 214b₂ and side openings 215. In a filter-press configuration, the first and the second upper openings 214a₁, 214a₂ of the additional cells 202 form, in conjunction with the first and second upper openings 208a₁, 208a₂ of the conductive bipolar plates 203, the two upper longitudinal ducts 211, while the first and the second lower openings 214b₁, 214b₂ of the additional cells 202 form, in conjunction with the first and second lower openings 208b₁, 208b₂ of the conductive bipolar plates 203, the two lower longitudinal ducts 212. In their turn, the side openings 215 of the additional cells 202 form, in conjunction with the side openings 209 of the conductive bipolar plates 203 the feeding ducts of the liquid water. The rigid perimetrical portion 202a is also provided with a multiplicity of holes 216 for housing the tie-rods.

Moreover, each additional cell 202 comprises gaskets 217 which are laid on both faces of the rigid perimetrical portion 202a so that they define on each face of the perimetrical portion itself: a collection channel of the gaseous

reactants 218a placed below the first and second upper openings 214a₁, 214a₂; a collection channel of the reaction products and the residual reactants 218b placed above the first and second lower openings 214b₁, 214b₂; a feeding channel 219 to connect one of the two upper openings 214a₁, 214a₂ to the collection channel of the gaseous reactants 218a; a discharge channel 220 to connect the collection channel of the reaction products and of the residual reactants 218b to one of the lower openings 214b₁, 214b₂; a fluid collection channel 221 placed below the collection channel of the gaseous reactants 218a and connecting the side openings 209. In a filter-press configuration, the collection channel of the gaseous reactants 218a is placed in correspondence of the upper calibrated holes 213a, the collection channel of the reaction products and of the residual reactants 218b is placed in correspondence of the lower calibrated holes 213b while the fluid collection channel 221 is placed in correspondence of the fluid injection calibrated holes 230. The gaskets 217 seal the collection channel of the gaseous reactants 218a, the collection channel of the reaction products and of the residual reactants 218b and the fluid collection channel 221 so as to hinder the passage of the gaseous reactants, of the reaction products and of the residual reactants and of liquid water inside the additional cell 202.

Moreover, the gaskets 217 are made of a soft material (silicone, elastomer etc.) compatible with the tightening/assemblage loads imposed by the sealing gaskets 207 of the reaction cell 201 and are laid on the rigid perimetrical

portion 202a by (injection or compression) moulding, mechanical anchoring or gluing.

The electrochemical generator 200 operates as follows. The gaseous reactants (fuel and oxidant) supplied to the electrochemical generator 200 through the upper longitudinal ducts 211 flow in the collection channels of the gaseous reactants 218a through the feeding channels 219. From here, the gaseous reactants, being unable to flow within additional cells 202 since the collection channels of the gaseous reactants 218 are sealed by gaskets 217, pass through the multiplicity of upper calibrated holes 213a placed on the conductive bipolar plates 203 of the adjacent reaction cells 201. In this way, the gaseous reactants reach the active area of the reaction cells 201 where the effective reaction takes place.

In their turn, the reaction products and the residual reactants generated in the reaction cells 201 pass through the multiplicity of lower calibrated holes 213b placed on the conductive bipolar plates 203 of the same reaction cells reaching the collection channels of the discharge products 218b of the adjacent additional cells 202. From here, they exit the electrochemical generator 200 through the discharge channels 220.

Furthermore, according to the present invention, the stream of liquid water supplied through the side ducts of the electrochemical generator 200 flows in the fluid collection channels 221 and from here, through the fluid injection calibrated holes 230, is injected into the reactant streams entering the adjacent

reaction cells 201 providing for the humidification of membrane 204 and for the thermal management of the electrochemical generator 200.

As an alternative to the fluid collection channel 221, the additional cell 202 may comprise two lateral fluid collection channels (222, 223) connected to the side openings 215 and placed below the collection channel of the discharge products 218b (figures 9a, 9b).

In this case, the flow of liquid water, prior to reaching the fluid injection calibrated holes 230 and being injected into the reaction cells 201, enters through the two lateral fluid collection channels 222, 223 to subsequently cross the whole surface of the current collector/distributor 206 of the additional cell 202 pre-heating counter-currently or concurrently with respect to at least one of the reactant flows entering the reaction cells 201. In this way the additional cells 202 act as cooling cells of the electrochemical generator 200.

Moreover, as shown in figures 10a, 10b, the fluid injection calibrated holes 230 of each conductive bipolar plate 203 may be placed above (rather than below) the upper calibrated holes 213a. In this case the fluid collection channel 221 is placed above the collection channel of the gaseous reactants 218a (figures 11a, 11b).

As an alternative, besides the fluid collection channel 221, the additional cell 202 may comprise a first and a second lateral channel 224, 225, placed above the collection channel of the discharge products 218b, and a third and a fourth lateral channel 226, 227 placed below the collection channel of the gaseous reactants 218a (figures 12a, 12b).

In this case, the flow of liquid water, prior to reaching the fluid injection calibrated holes 230 and being injected into the reaction cells 201, enters the first and second lateral channel 224, 225 and exits from the third and fourth lateral channel 226, 227 crossing the current collector/distributor 206 of the additional cell 202 so that it is pre-heated counter-currently or concurrently with respect to at least one of the reactant streams supplied to the reaction cells 201.

The advantages obtainable with the above described electrochemical generators are the following.

First, the fluid injection calibrated holes 20, 230 permit to obtain a uniform distribution of the calibrated flow of liquid water inside the reaction cells 2, 201. In this way, the cooling of the electrochemical generators 1, 100, 200 as the hydration of the proton-exchange membranes 4, 204 result more uniform, with the effect of increasing the operative life of the same membranes besides enhancing the liquid water evaporative mechanism, thus decreasing the required flow-rate for the thermal management of the same generators.

Moreover, the liquid water flow pre-heating achieved by the use of the additional cells shown in figures 5b, 9a, 9b and 12a, 12b amplifies the above disclosed advantages since it further enhances the liquid water evaporative mechanism allowing a further reduction of the time for reaching steady-state conditions at the start-up of the electrochemical generators 1, 100, 200.

It is finally evident that modifications and variations can be made to the described electrochemical generators, without departing from the domain of the present invention.

CLAIMS

1. Membrane electrochemical generator (1, 100, 200) fed with gaseous reactants and comprising a multiplicity of reaction cells (2, 201) being delimited by conductive bipolar plates (3, 203) among which is comprised a proton-exchange membrane (4, 204), characterised in that said conductive bipolar plates (3, 203) comprise a multiplicity of fluid injection calibrated holes (20, 230) for the injection of a calibrated flow of a cooling fluid inside said reaction cells (2, 201).
2. Generator according to claim 1, characterised in that each of said reaction cells (2, 201) is formed by an anodic chamber (9) and a cathodic chamber (10) separated by said membrane (4, 204), said anodic chamber (9) and said cathodic chamber (10) each comprising an electrically conductive reticulated element (7, 206) at whose interior said calibrated flow of said cooling fluid partially evaporates simultaneously providing for the humidification of said gaseous reactants and for the thermal management of said membrane electrochemical generator (1, 100, 200).
3. Generator according to claim 1 or 2, characterised in that said fluid injection calibrated holes (20, 230) are mutually aligned and placed in correspondence of feed openings (12, 13, 208a1, 208a2) for feeding said gaseous reactants and of side openings (16, 209) for feeding said cooling fluid (12, 13, 208a1, 208a2) and said side openings (16, 209) being obtained in a perimetrical portion (11, 208) of said conductive bipolar plates (3, 203).

4. Generator according to anyone of claims 1-3, characterised in that said fluid injection calibrated holes (20, 230) have the same diameter comprised between 0,2 mm ÷ 1 mm.

5. Generator according to anyone of the previous claims, characterised in that said conductive bipolar plates (3) are interposed between a pair of sealing gaskets (8a, 8b) of two adjacent reaction cells (2), said sealing gaskets (8a, 8b) each realising a seat for a respective electrically conductive reticulated element (7) and comprising:

- respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) for the passage of said gaseous reactants;
- respective side openings (8a₅, 8b₅) for the passage of said cooling fluid;
- respective distribution channels (21a, 23a) to connect said respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) to said respective electrically conducting reticulated element (7).

6. Generator according to claim 5, characterised in that at least one of said sealing gaskets (8a, 8b) comprises respective fluid collection channels (22) connected to said respective side openings (8a₅, 8b₅), said fluid collection channels (22) being interposed between said respective feed openings (8a₁, 8a₂, 8b₁, 8b₂) and said respective distribution channels (21a, 23a) and being suited to collect said cooling fluid.

7. Generator according to claim 5 characterised in that at least one of said sealing gaskets (8a, 8b) comprises respective fluid collection channels (22) connected to said respective side openings (8a₅, 8b₅) and to said respective

distribution channels (21a, 23a), said respective fluid collection channels (22) being interposed between said respective feed openings (8a1, 8a2, 8b1, 8b2) and said respective distribution channels (21a, 23a) and being suited to collect said cooling fluid.

8. Generator according to claim 6 or 7, characterised in that in a filter-press configuration said fluid collection channels (22) present on at least one of the sealing gaskets (8a, 8b) are superposed to said fluid injection calibrated holes (20) and that each of said fluid injection calibrated holes (20) is in correspondence of a distribution channel (21a, 23a) obtained on the other sealing gasket (8a, 8b).

9. Generator according to anyone of claims 1-4, characterised in that it comprises a multiplicity of additional cells (101), each of the additional cells (101) being interposed between a pair of reaction cells (2), realising a seat for a respective electrically conductive reticulated element (7) and comprising a perimetrical portion (102a) in which are obtained:

- side openings (104) for the passage of said cooling fluid;
- at least one fluid collection channel (106) connected to said side openings (104) and suited to collect said cooling fluid;
- feed openings (103a₁, 103a₂) for the passage of said gaseous reactants;
- discharge openings (103b₁, 103b₂) for discharging the reaction products and residual reactants.

10. Generator according to claim 9, characterised in that said fluid collection channel (106) is placed below said feed openings (103a₁, 103a₂).

11. Generator according to claim 9 or 10, characterised in that, in a filter-press configuration, said fluid collection channel (106) is superposed to said fluid injection calibrated holes (20) of said conductive bipolar plates (3).
12. Generator according to claim 9, characterised in that said fluid collection channel (106) is formed by a first and a second side portion (107, 108) placed above said discharge openings (103b₁, 103b₂).
13. Generator according to claim 12, characterised in that said cooling fluid, prior to reaching said fluid injection holes (20), crosses the whole surface of said respective electrically conductive reticulated element (7) pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (2).
14. Generator according to anyone of claims 1-4, characterised in that said conductive bipolar plates (203) comprise a multiplicity of first calibrated holes (213a) for the passage of said gaseous reactants and a multiplicity of second calibrated holes (213b) for the discharge of reaction products and of optional residual reactants and that said multiplicity of fluid injection calibrated holes (230) are placed in correspondence of said multiplicity of first calibrated holes (213a).
15. Generator according to claim 14, characterised in that said first calibrated holes (213a) are mutually aligned and placed in correspondence of said feed openings (208a₁, 208a₂) of said conductive bipolar plates (203) and that said second calibrated holes (213b) are mutually aligned and placed in

correspondence of discharge openings (208b₁, 208b₂) obtained on said perimetrical portion (208) of said conductive bipolar plates (203).

16. Generator according to claim 14 or 15, characterised in that said reaction cells (201) comprise a sealing gasket (207) covering only one face of said perimetrical portion (208) of said conductive bipolar plates (203), said sealing gasket (207) realising a seat for a respective electrically conductive reticulated element (206).

17. Generator according to anyone of claims 14-16, characterised in that it comprises a multiplicity of additional cells (202), each of the additional cells (202) being interposed between a pair of reaction cells (201) and comprising a rigid perimetrical portion (202a) and a hollow central portion (202b), said rigid perimetrical portion (202a) acting as separating surface for said gaseous reactants and said hollow central portion (202b) realising a seat for a respective electrically conductive reticulated element (206).

18. Generator according to claim 17, characterised in that said rigid perimetrical portion (202a) is provided with feed openings (214a₁, 214a₂) for feeding said gaseous reactants, of discharge openings (214b₁, 214b₂) for discharging the reaction products and the residual reactants and of side openings (215) for the passage of said cooling fluid.

19. Generator according to claim 17 or 18, characterised in that said rigid perimetrical portion (202a) is covered on each face by a gasket (217), said gasket (217) defining on each face of said rigid perimetrical portion (202a) a zone of collection of the gaseous reactants (218a) placed in correspondence of

said feed openings (214a₁, 214a₂) of said rigid perimetrical portion (202a), a zone of collection of the reaction products and of the residual reactants (218b) placed in correspondence of said discharge openings (214b₁, 214b₂) of said rigid perimetrical portion (202a), a feed channel (219) to connect one of said feed openings (214a₁, 214a₂) to said zone of collection of the gaseous reactants (218a), a discharge channel (220) to connect said zone of collection of the reaction products and of the residual reactants (218b) to one of said discharge openings (214b₁, 214b₂).

20. Generator according to claim 19, characterised in that said gasket (117) seals said zone of collection of the gaseous reactants (218a) and said zone of collection of the reaction products and of the residual reactants (218b) so as to hinder the passage of said gaseous reactants and of said reaction products and optional residual reactants within said additional cell (202).

21. Generator according to claim 19 or 20, characterised in that in a filter-press configuration said zone of collection of the gaseous reactants (218a) is superposed to said first calibrated holes (213a) and said zone of collection of the reaction products and of the residual reactants (218b) is superposed to said second calibrated holes (213b).

22. Generator according to anyone of claims 19-21, characterised in that said fluid injection calibrated holes (230) are placed below said first calibrated holes (213a) and that said gasket (217) defines on each face of said rigid perimetrical portion (202a) a fluid collection channel (221) placed below said feed openings (214a₁, 214a₂) of said additional cells (202).

23. Generator according to anyone of claims 19-21, characterised in that said fluid injection calibrated holes (230) are interposed between said feed openings (208a₁, 208a₂) of said bipolar plates (203) and said first calibrated holes (113a, 113b) and that said gasket (217) defines on each face of said rigid perimetrical portion (202a) a fluid collection channel (221) interposed between said feed openings (214a₁, 214a₂) of said additional cell (202) and said zone of collection of the gaseous reactants (118a).

24. Generator according to claim 22 or 23, characterised in that in a filter-press configuration said fluid collection channel (221) is superposed to said fluid injection calibrated holes (230).

25. Generator according to anyone of claims 19-21, characterised in that said additional cells (202) comprise a first and a second fluid collection lateral channel (222, 223) connected to said side openings (215) of said additional cells (202) and placed above said discharge openings (214b₁, 214b₂) of said additional cells (202) and that said cooling fluid, prior to reaching said fluid injection holes (230) passes through said first and second fluid collection lateral channel (222, 223) to cross subsequently the whole surface of said respective electrically conductive reticulated element (206) pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (201).

26. Generator according to anyone of claims 19-21, characterised in that said additional cells (202) comprise:

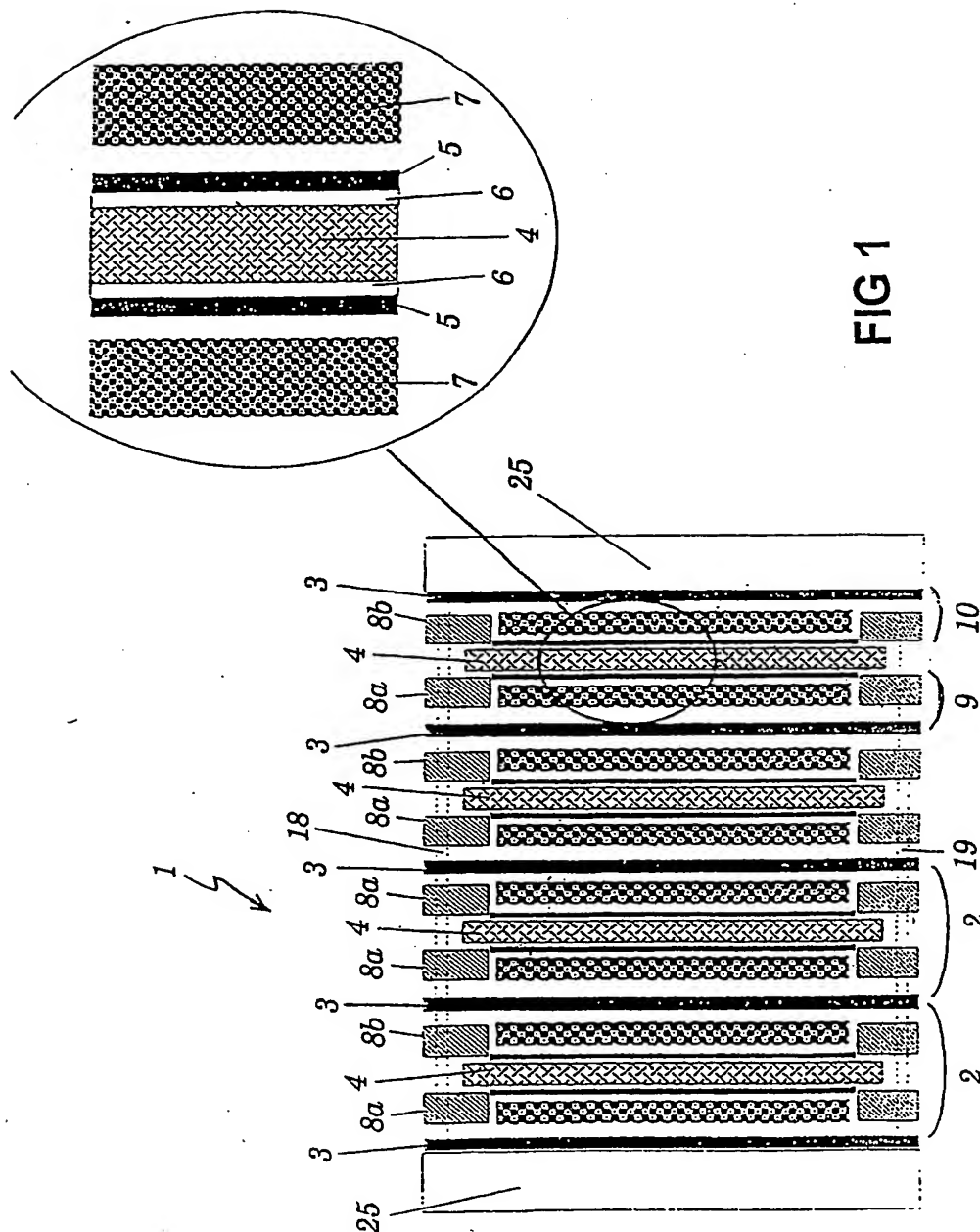
- a first and a second fluid collection lateral channel (224, 225) connected to said side openings (215) of said additional cells (202) and placed above said discharge openings (214b₁, 214b₂) of said additional cells (202);
- a third and a fourth fluid collection lateral channel (226, 227) connected to said side openings (215) of said additional cells (202) and placed below said feed openings (214a₁, 214a₂) of said additional cells (202);
- a fluid collection channel (221) interposed between said feed openings (214a₁, 214a₂) of said additional cells (202) and said zone of collection of the gaseous reactants (218a) and connected to said side openings (215) of said additional cells (202);

and that said cooling fluid, prior to reaching said fluid injection holes (230) enters through said first and second fluid collection lateral channel (224, 225) to subsequently cross the whole surface of said respective electrically conductive reticulated element (206), pre-heating counter-currently or concurrently with respect to at least one gaseous flow entering said reaction cells (201), said cooling fluid subsequently exiting from said third and fourth fluid collection lateral channel (226, 227);

and that in a filter-press configuration said fluid collection channel (221) is superposed to said fluid injection calibrated holes (230).

27. Generator according to anyone of the previous claims, characterised in that said cooling fluid is liquid water.

28. Membrane electrochemical generator, substantially as described with reference to the annexed figures.



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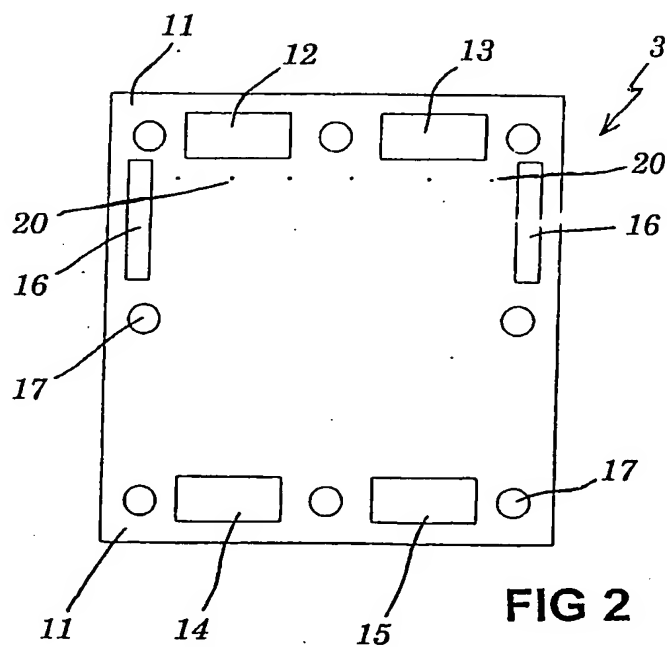


FIG 2

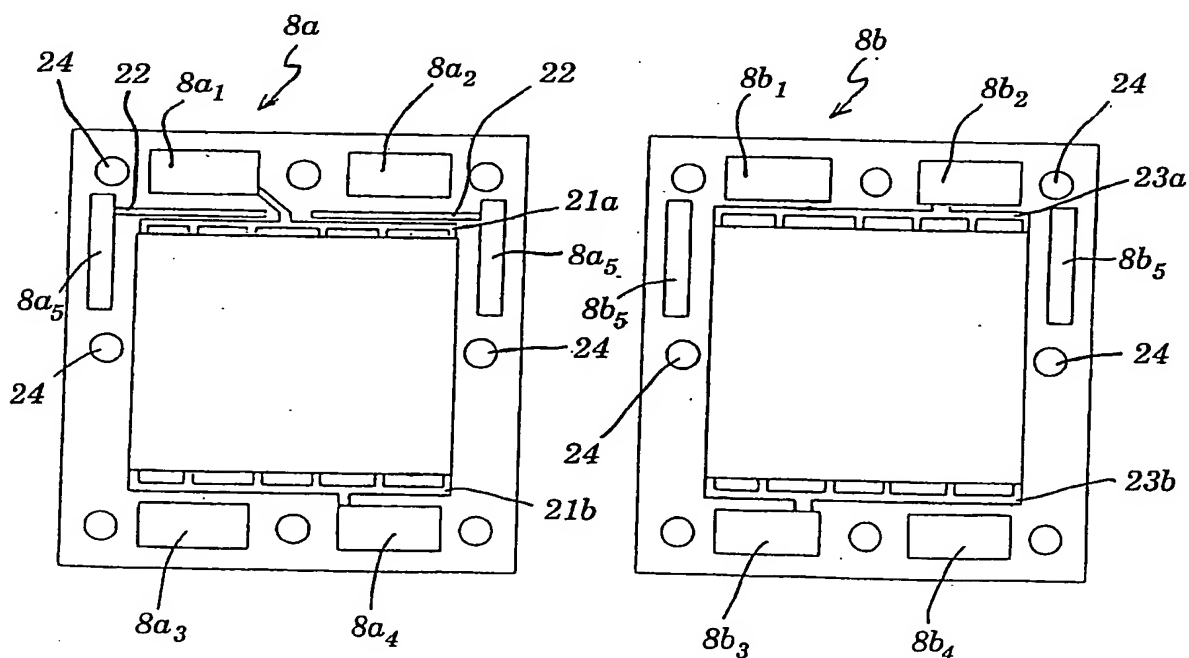


FIG 3a

FIG 3b

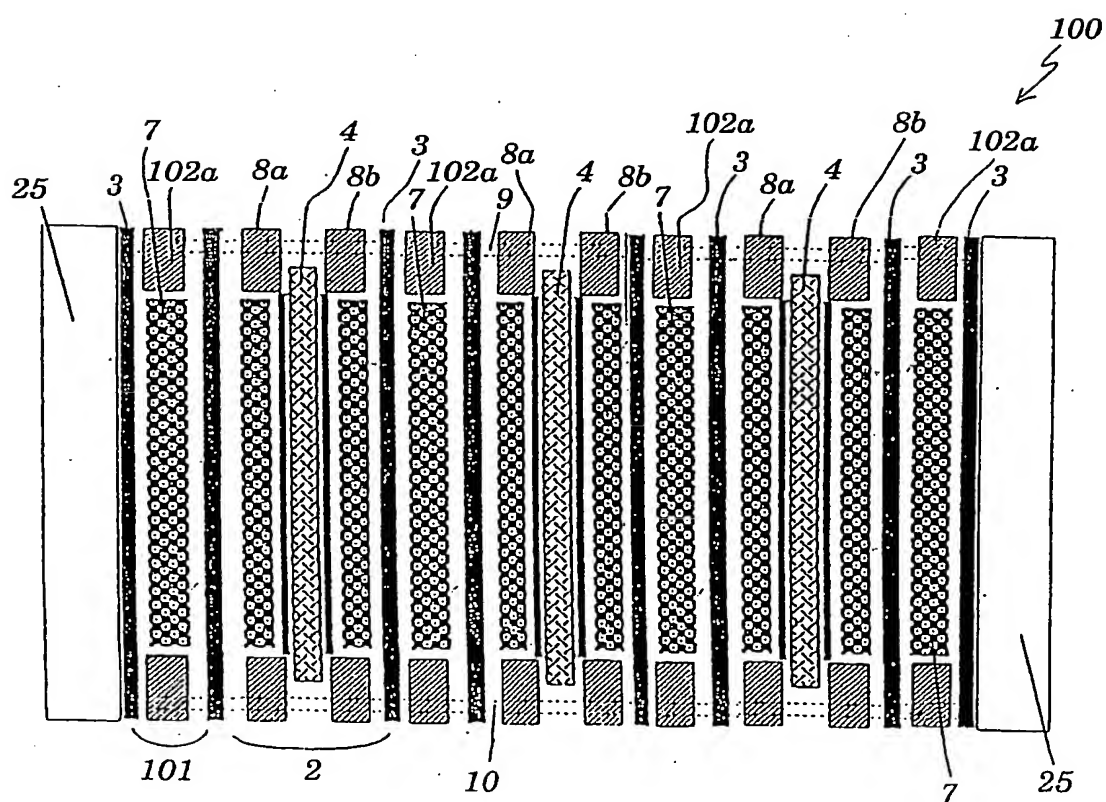
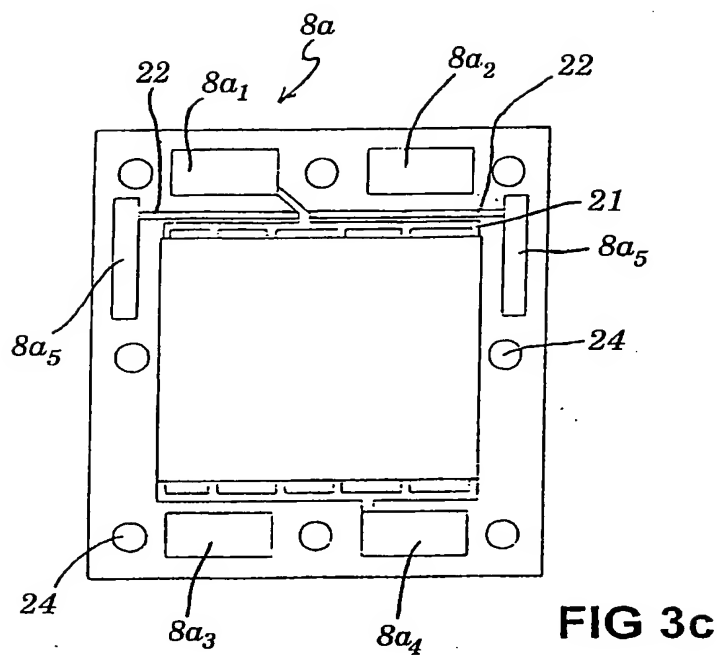


FIG 4

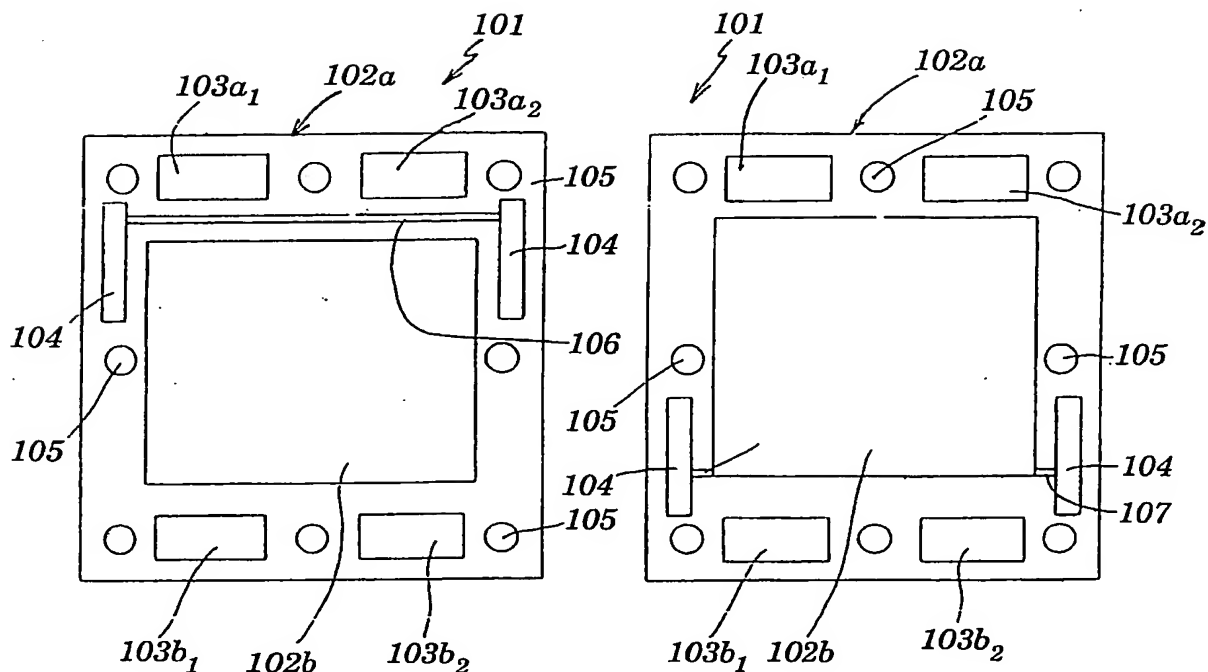
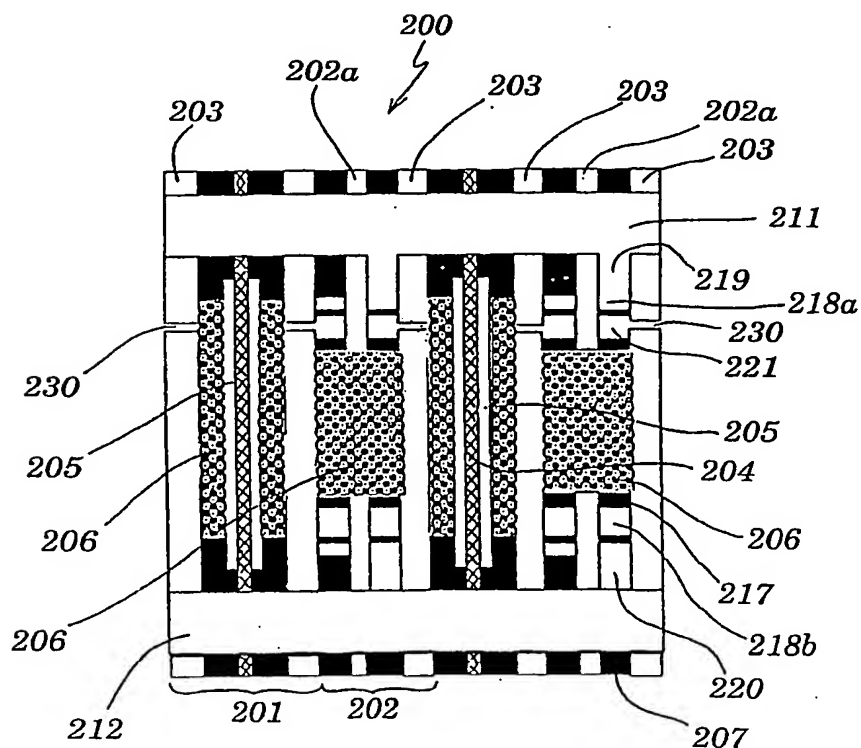


FIG 5a

FIG 5b



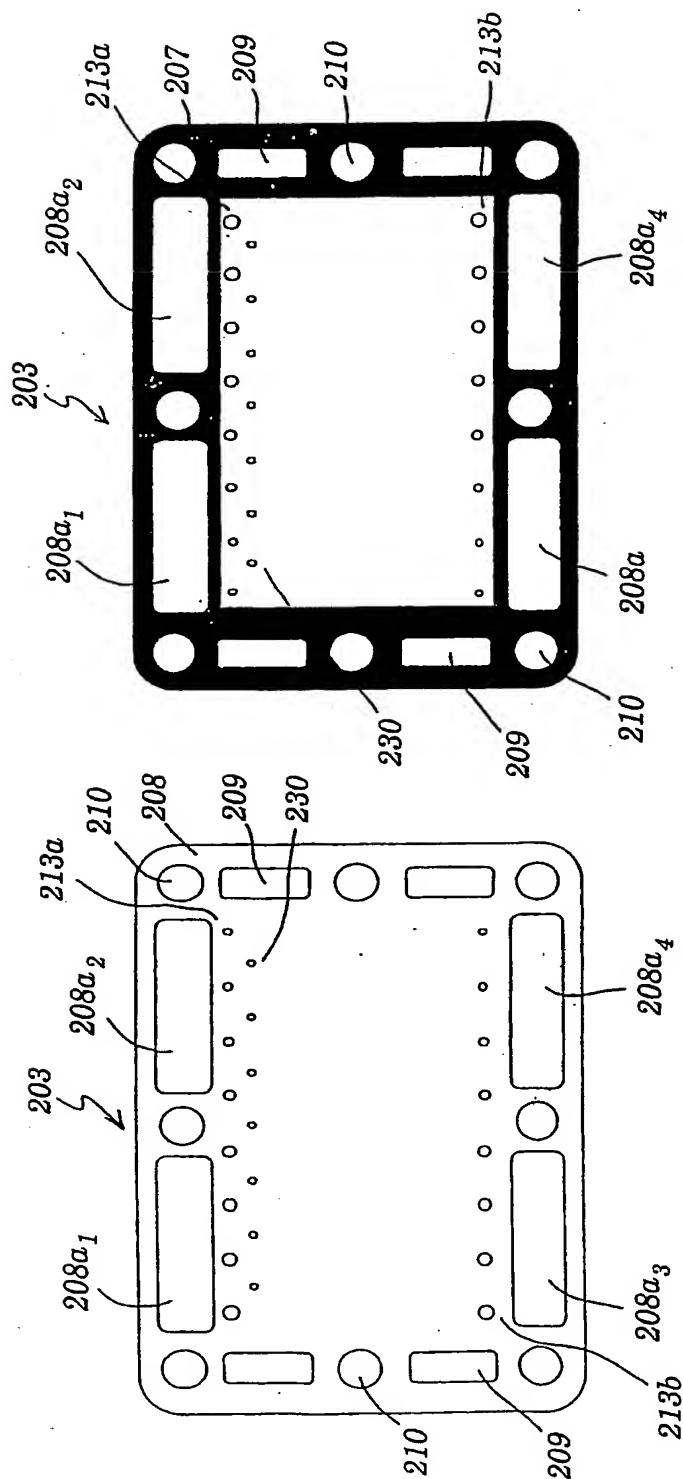


FIG 7b

FIG 7a

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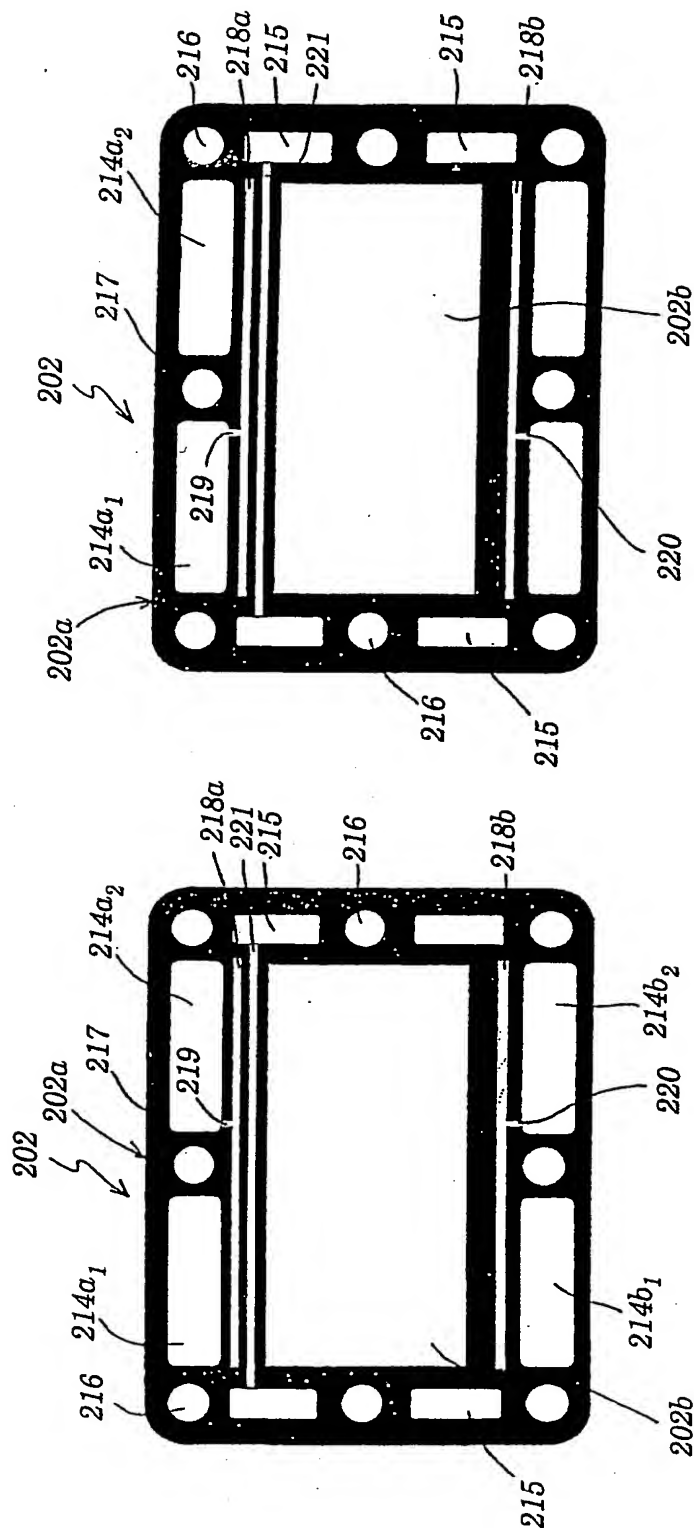
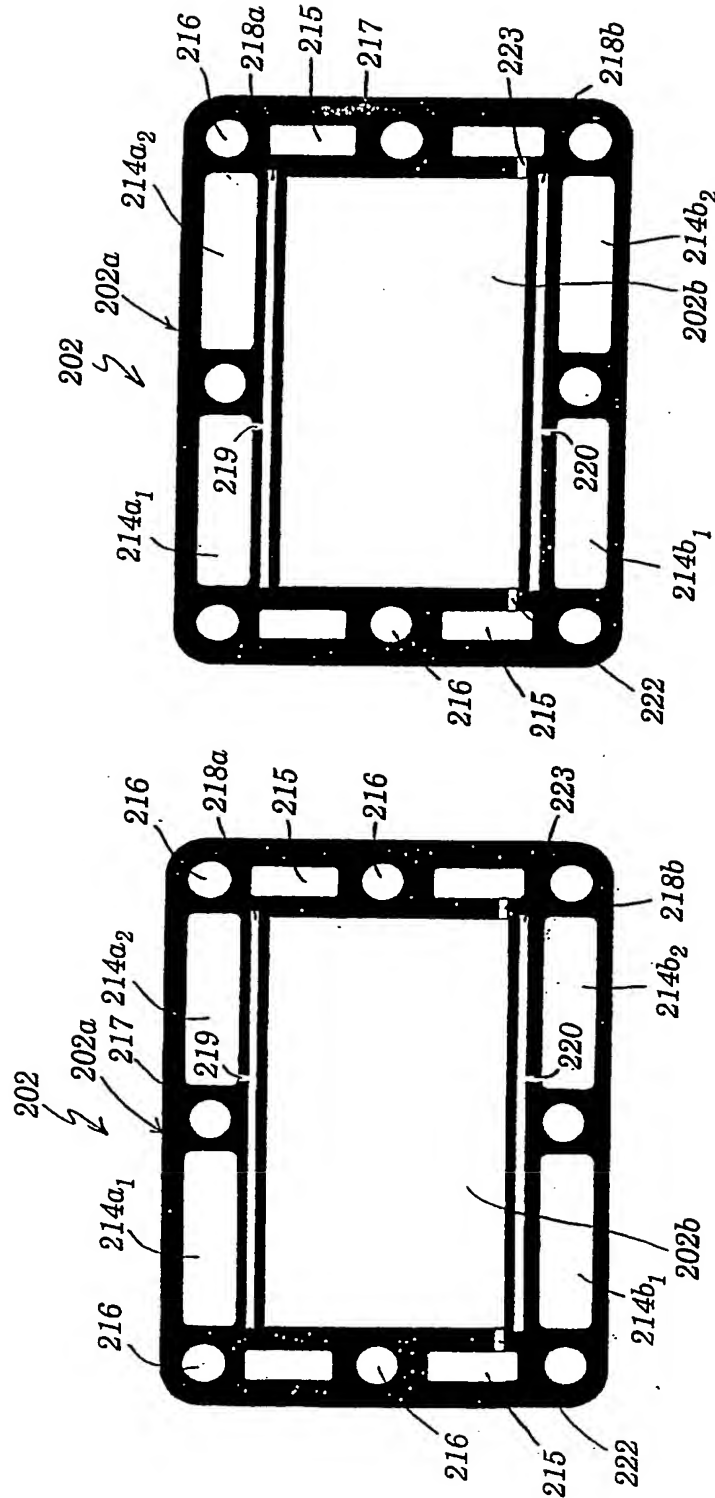


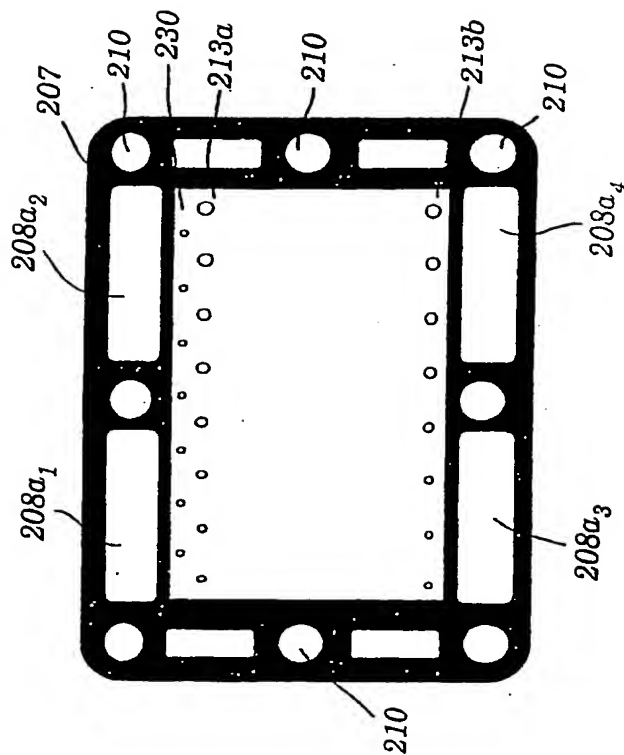
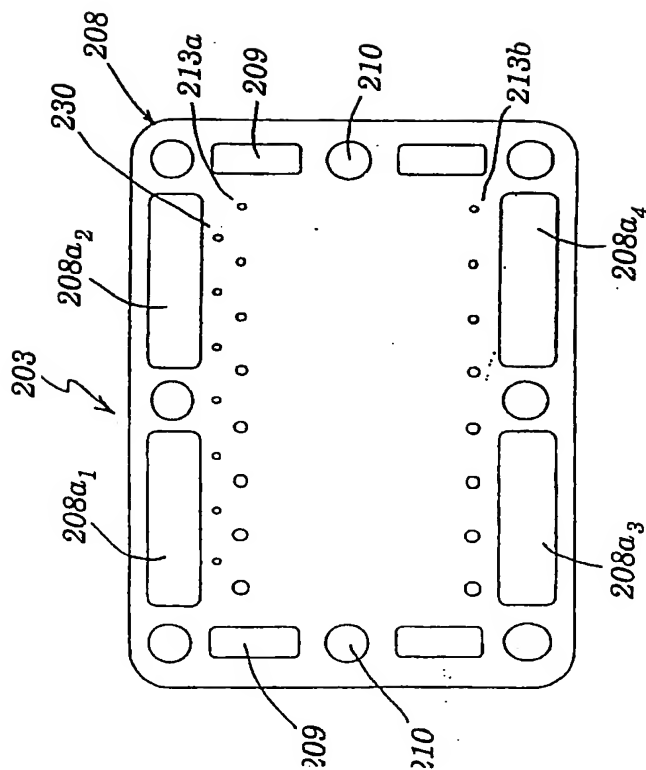
FIG 8b

FIG 8a

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8/10



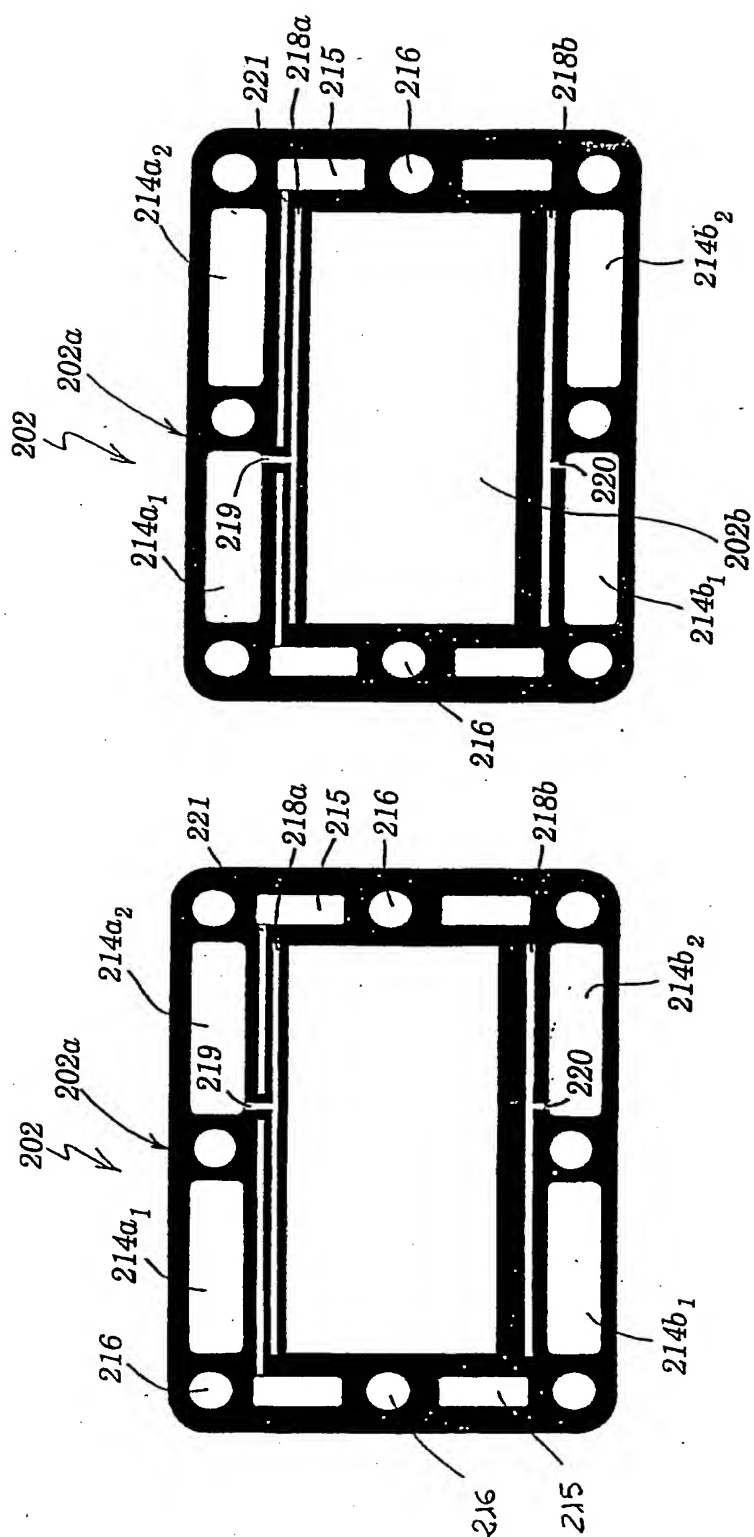


FIG 11a

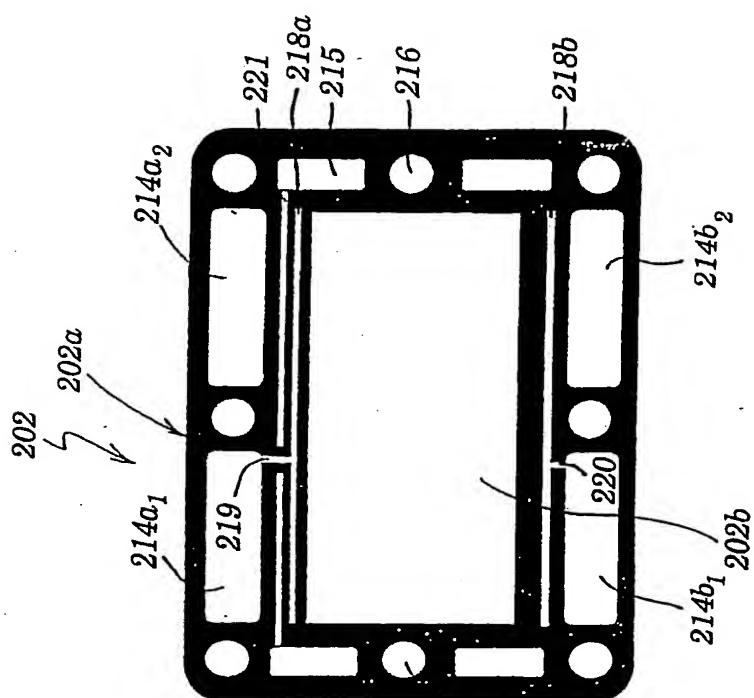


FIG 11b

10/10

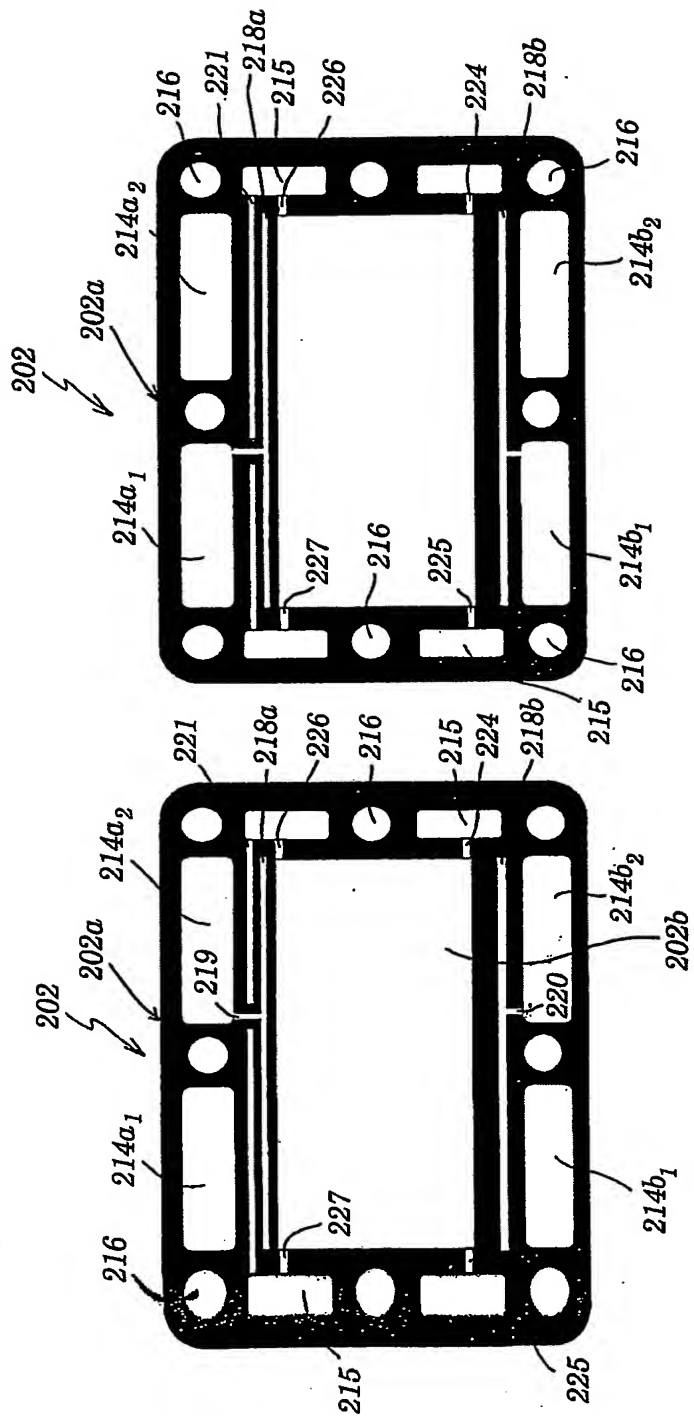


FIG 12b

FIG 12a

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/EP 03/06327

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M8/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 998 054 A (JONES DANIEL O ET AL) 7 December 1999 (1999-12-07)	1-8
Y	column 5, line 11-14, 64-67 column 6, line 26-49 column 7, line 5-50 column 8, line 13-26 figures 2-4	9-13
X,P	EP 1 286 404 A (EQUOS RES KK) 26 February 2003 (2003-02-26) paragraphs '0082!-'0093! figures 15-17, 20-23	1-3, 5

-/--

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex:

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition, or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *G* document member of the same patent family

Date of the actual completion of the international search

23 October 2003

Date of mailing of the international search report

03/11/2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016

Authorized officer

Jacquinot, P

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/EP 03/06327

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5998054	A	07-12-1999	AU 7132398 A	16-02-1999
			WO 9905740 A1	04-02-1999
			US 6528198 B1	04-03-2003
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			EP 1286404 A2	26-02-2003
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			WO 0070698 A1	23-11-2000
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			EP 1171926 A1	16-01-2002
			JP 2002542591 T	10-12-2002
			TW 499779 B	21-08-2002

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference M/44167-PCT	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/EP 03/ 06327	International filing date (day/month/year) 16/06/2003	(Earliest) Priority Date (day/month/year) 17/06/2002
Applicant NUVERA FUEL CELLS EUROPE S.R.L.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 5 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the title,

the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

FUEL CELL WITH EVAPORATIVE COOLING AND HUMIDIFICATION

5. With regard to the abstract,

the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

6

None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The present invention relates to a membrane electrochemical generator (200) formed by a multiplicity of reaction cells (201) mutually connected in electrical series and assembled according to a bipolar configuration. In accordance with the present invention, the thermal management of the membrane electrochemical generator (200) and the hydration of the membrane (204) are ensured by the injection of a cooling fluid, preferably liquid water, in the gaseous reactant feed. Such an injection takes place through a multiplicity of calibrated fluid injection holes (230) obtained in conductive bipolar plates (203) delimiting the reaction files (201). The cooling fluid can be preheated by passing through a collector/distributor structure (206) located in an additional cell (202).

INTERNATIONAL SEARCH REPORT

International Application No

PC 03/06327

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01M8/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 998 054 A (JONES DANIEL O ET AL) 7 December 1999 (1999-12-07)	1-8
Y	column 5, line 11-14, 64-67 column 6, line 26-49 column 7, line 5-50 column 8, line 13-26 figures 2-4	9-13
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Date of the actual completion of the international search

23 October 2003

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A	page 11, line 13 -page 12, line 25 page 15, line 10 -page 16, line 12 examples 1-3	1-8, 14-28
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